AMERICAN UNIVERSITY OF BEIRUT

MIDDLE SCHOOL STUDENTS' UNDERSTANDING OF NON-TECHNICAL VOCABULARY FOUND IN AMERICAN SCIENCE TEXTBOOKS USED IN A LEBANESE SCHOOL

by
DIALA MOHAMAD NABIL BADREDDINE

A thesis
submitted in partial fulfillment of the requirements
for the degree of Master of Arts
to the Department of Education
of the Faculty of Arts and Sciences
at the American University of Beirut

Beirut, Lebanon
January 2019

AMERICAN UNIVERSITY OF BEIRUT

MIDDLE SCHOOL STUDENTS' UNDERSTANDING OF NON-TECHNICAL VOCABULARY FOUND IN AMERICAN SCIENCE TEXTBOOKS USED IN A LEBANESE SCHOOL

by
DIALA MOHAMAD NABIL BADREDDINE

Approved by:

Dr. Tamer Amin, Associate Professor and Chair — Advisor
Department of Education

Dr. Saouma BouJaoude, Professor — Member of Committee
Department of Education

Dr. Rola Khishfe, Associate Professor — Member of Committee
Department of Education

Date of thesis defense: January 23, 2019

AMERICAN UNIVERSITY OF BEIRUT

THESIS, DISSERTATION, PROJECT RELEASE FORM

Student Name: ____Badreddine________________Diala____________Mohamad Nabil
Last First Middle

☑ Master's Thesis ○ Master's Project ○ Doctoral Dissertation

☑ I authorize the American University of Beirut to: (a) reproduce hard or electronic copies of my thesis, dissertation, or project; (b) include such copies in the archives and digital repositories of the University; and (c) make freely available such copies to third parties for research or educational purposes.

☐ I authorize the American University of Beirut, to: (a) reproduce hard or electronic copies of it; (b) include such copies in the archives and digital repositories of the University; and (c) make freely available such copies to third parties for research or educational purposes after : **One ---- year from the date of submission of my thesis, dissertation, or project.**
Two ---- years from the date of submission of my thesis, dissertation, or project.
Three ---- years from the date of submission of my thesis, dissertation, or project.

Diala ____________ February 15, 2019

Signature Date

This form is signed when submitting the thesis, dissertation, or project to the University Libraries

ACKNOWLEDGMENTS

I would like to express my profound appreciation to my advisor Dr. Tamer Amin for his continued support and guidance throughout this journey. Dr. Tamer has been a mentor to me since my first days as a student enrolled in the Teaching Diploma program and was the driving force for me to enroll in the science education graduate program. His patience, dedication and encouragement have helped me to continuously push myself in order to deliver the best work. I would never have been able to complete the thesis if it weren't for his assistance in retrieving research which was central for my study. I am also extremely grateful for the research experience I have gained from working as his graduate assistant for the past few years.

I would also like to share my deep gratitude to Dr. Saouma BouJaoude for his encouragement and his valuable feedback throughout this work. It was during one of Dr. Saouma's engaging classes that I first became interested in exploring my research topic. I would also like to express my deep appreciation to Dr. Rola Khishfe for her valuable feedback and comments which greatly helped me improve my work.

This journey would have not been possible without the love and support of my friends and sisters Aya, A'alaa and Hiba. Thank you for all the times you encouraged me not to give up. Last but not least, words cannot describe my immense gratitude to my parents. Thank you for being my role models and for teaching me the meaning of hard work and perseverance. I am blessed to have your unconditional love and support. Finally, I am grateful for my husband, Mohamad, who has been my partner in this long journey. Thank you for believing in me since day one and for always pushing me to be the best I can be. Your love, support and motivation have and will always be my guiding light.

AN ABSTRACT OF THE THESIS OF

Diala Mohamad Nabil Badreddine for Master of Arts
Major: Science Education

Title: Middle School Students' Understanding of Non-Technical Vocabulary Found in American Science Textbooks Used in a Lebanese School

A fundamental component of scientific literacy is students' ability to read and understand from science texts (Norris & Phillips, 2003; Osborne, 2002). Yet this remains a major challenge for both native and non-native English language learners (ELLs) who struggle in understanding the specialized language of science found in science textbooks. Specifically, one of the challenging features of the language of science is the presence of non-technical terms which are identified as everyday terms that have specialized meanings in science. However, the difficulties associated with understanding non-technical terms are compounded for ELLs since they have to learn the language of science while still developing their reading and literacy skills (Tong, Irby, Lara-Alecio & Koch, 2014). The aim of this study was to investigate middle school ELLs' understanding of non-technical terms commonly encountered in American science textbooks used in a Lebanese school. Participants in the study included 167 middle school ELLs enrolled in a Lebanese private school in Beirut. All participants completed a test which examined the comprehension of 50 non-technical terms commonly encountered in their American science textbook. In order to further clarify student responses, five students were randomly selected to participate in semi-structured interviews. Results showed that students had a weak understanding of the majority of nontechnical terms. Specifically, students confused non-technical terms with words that look or sound the same, words that have imprecise meaning and words with opposite meanings. Results also showed that students' understanding of terms was inconsistent and did not improve systematically across grade levels. Furthermore, the Preliminary Scholastic Aptitude Test (PSAT) was found to be a good predictor of students' understanding of non-technical terms.

CONTENTS

Appendix

ILLUSTRATIONS

TABLES

CHAPTER I

INTRODUCTION

The problems related to meeting the science literacy demands in schools is a major focus of investigation and discussion in the international science education community (Hand, Praine & Yore, 2001; Next Generation Science Standards Lead States, 2013; Osborne, 2002; Pearson, Moje & Greenleaf, 2010; Reiss, Millar & Osborne, 1999; United Nations Educational Scientific and Cultural Organization [UNESCO], 1994; Webb, 2010)**.** A fundamental component of scientific literacy is students' ability to read and understand from science texts (Norris & Phillips, 2003; Osborne, 2002). Yet the abundance of technical and non-technical terminology is among the many features that make the language of science the most challenging part of learning science (Lemke, 1990; Wellington & Osborne, 2001). While numerous studies have focused on the difficulties associated with understanding technical words, literature has identified non-technical terminology as an even greater hindrance to the comprehension of science texts (Abdul-Hamid & Samuel, 2012; Cassels & Johnstone, 1983, 1985; Childs & O'Farrell, 2003; Cohen, Glasman, Rosenbaum-Cohen, Ferrara & Fine, 1979; Slater; 1978; Tao, 1994; Todd-Trimble, Trimble & Drobinic, 1978).

Language assumes a central and important role in the learning process (Osborne, 2002; Welington & Osborne, 2001; Wells, 1994; Vygtosky, 1962, 1978). In his sociocultural theory of development and learning, Vygotsky (1962, 1978) emphasizes the link between language, in the form of inner speech, and the development of cognition. The function of language in this sense is not only related to communication via oral and written speech, but also acts as a tool for thought (Vygotsky, 1978). In fact, he maintains that "thought is born through words" and "a word devoid of thought is a dead thing" indicating that language is inseparable from thought (Vygotsky, 1962,

p. 225). Furthermore, Halliday (1993) explains that "the distinctive characteristic of human learning is that it is a process of making meaning; a semiotic process; and the prototypical form of human semiotics is language" (p. 42). In the context of science, the need to effectively present scientific information and develop arguments is facilitated by the use of specialized language containing special syntax, semantics, lexicon and structure which is not used in everyday ordinary language (Fang, 2006; Schleppegrell, 2001). Without proper understanding of the language of science, students are at a great disadvantage in acquiring scientific knowledge. According to functional linguistics, learning this specialized language is synonymous with learning science (Fang, 2005). Similarly, Sutton (1998) identifies science learning as learning to talk in new ways while Lemke (1990) states that learning science involves learning to talk science.

Despite the role of language in learning science, students have the false perception that science learning is restricted to the lab (Osborne, 2002). In reality, a huge part of scientists' work involves communicating ideas via a variety of formal and informal methods such as peer reviewed journals, conferences, emails and phone calls (Next Generation Science Standards Lead States, 2013; Sutton, 1998). Given the centrality of reading and writing in science, the Next Generation Science Standards (NGSS) (Next Generation Science Standards Lead States, 2013), identifies reading and writing as fundamental practices required in science class. Furthermore, Norris and Philips (2003) expanded on the definition of scientific literacy to include reading and writing by differentiating between the derived and fundamental senses of scientific literacy. The derived sense involves science content knowledge while the fundamental sense requires proficiency in the reading, writing and talking science.

Over time, the language of science has developed away from ordinary everyday talk as a way to cater for the demands of the scientific method and scientific arguments (Halliday & Martin, 1993; Sutton, 1998). This has resulted in science being referred to as a culture with a language of its own (Gee, 2004; Roth & Lawless, 2002; Wellington & Osborne, 2001). Research on the language of science has identified the gradual fading of characteristics such as the scientist's personal voice and the replacement of a formal and passive voice as a way to create distance between scientists and their findings (Sutton, 1998). Science textbooks have adopted these features and as a result portrayed the language of science as passive, rigid and detached (Fang, 2006; Sutton, 1998). Other problematic features include the use of logical connectives which are words or phrases used to create logical relationships between ideas and establish relationship between data (Gardner, Schafe, Myint Thein & Watterson, 1976; Osborne, 2002; Wellington & Osborne, 2001). Furthermore, science texts are often characterized by high information density which is evident by the increased number of content words (Halliday, 1993). Writers are compelled to achieve brevity while also organizing and summarizing data through the use of language tools such as nominalization and ellipsis (Fang, 2006). Nominalization involves changing verbs and adjectives, used to refer to processes and characteristics of objects, respectively, to nouns and nouns phrases resulting in texts that are more abstract (Fang, 2006; Fang & Schleppegrell, 2010; Halliday & Mathiessen, 2004; Martin & Rose, 2007) while ellipsis is the omission of words, phrases or clauses (Fang, 2006).

Other problematic features include the use of technical and non-technical terms (Ali & Ismail, 2006, Carnine & Carnine, 2004; Fang, 2005, Fang & Schleppegrell, 2010, Snow, 2010; Taboada, 2012). Technical terminology, commonly marked in bold, has a specialized subject-specific meaning (Eggins, Wignell & Martinc, 1993) while non-technical terms are ordinary words used in everyday context but often have specialized meanings when used in science (Childs & O'Farrell, 2003; Fang, 2006; Johnstone & Selepeng, 2001; Lee, Maerten-Rivera, Penfield, LeRoy & Secad, 2008). More specifically, Cohen et al. (1979) differentiated between three categories of non-technical terms: terms which adopt a technical meaning in a specialized field (e.g. recognition, specific), and words that appear as paraphrases for other words (e.g. repair process, repair scheme) or terms that refer to time sequence or frequency also known as technical lexis (e.g. intermittently, subsequently, consecutively). Given the conception that comprehension of technical terms is the most essential part of student understanding of text, it is common practice for science teachers to focus on teaching and highlighting these terms (Cohen et al., 1979). However, even students competent in understanding technical words face difficulties when reading science texts. In comparing the difficulties associated with technical and non-technical terms, research has revealed that the latter are more problematic (Abdul-Hamid & Samuel, 2012; Cassels & Johnstone, 1983, 1985; Childs & O'Farrell, 2003; Cohen et al., 1979; Slater; 1978; Tao, 1994; Todd-Trimble et al., 1978).

Consequently, due to these specialized features, even the most competent readers and word-decoders find difficulty understanding science texts, which can appear as a series of incoherent words (Best, Rowe, Ozuru, & McNamara, 2005; Snow, 2010). This problem is especially evident at the middle school level during which students are expected to read to learn science (Fang & Wei, 2010, Lara-Alecio et al., 2012; Tong, Irby, Lara-Alecio & Koch, 2014). The problems associated with understanding science texts are common to all students yet they are amplified for English language learners (ELLs) due to their limited English language proficiency and literacy development (Bravo & Cervetti, 2014; Lara-Alecio et al., 2012; Lee, Quinn & Valedes, 2013, Taboada, Bianco & Bowerman, 2012; Taboada & Rutherford, 2011;

Tong et al., 2014). These students, whose first language is not English, are required to learn the specialized language of science while still developing English language proficiency (Tong et al., 2014). This is especially evident in the Arab world where, due to its colonial history, numerous Arab countries, including Lebanon, have chosen to adopt English or French as the medium of instruction for science.

The exposure to foreign languages in Lebanon started at the beginning of the 17th century with the arrival of Western missionaries and the establishment of French, British and American schools (Esseili, 2014). Following the end of World War I, Lebanon was under the French mandate (1920-1943) and was influenced by the French educational system, which resulted in declaring French and Arabic as compulsory languages of instruction (Shaaban & Ghaith, 1999). Since its independence in 1943, instruction in the second languages of English and French has been on the rise in Lebanon (Esseili, 2014). The current Lebanese curriculum established a trilingual language policy whereby all students are instructed in Arabic for some subjects and in a foreign language, English and French, for others. This has led to numerous schools offering parallel Anglophone and Francophone tracks.

The demand for English as a language of instruction has increased mainly due to the impact of globalization (Shaaban & Ghaith, 2002) and the realization that English is central for the communication and explanation of science concepts (Rollnick, 2000). In fact, the Center for Educational Research and Development statistics (CERD, 2016) reveals an increase in the percentage of students instructed in English from 35.8% in the academic year 2004-2005 to 46.9% in the academic year 2015-2016. More specifically, private schools in Lebanon, which was the focus of this study, have witnessed an increase in student enrollment in English tracks from 39.3% in 2004-2005 to 46.9% in 2015-2016.

Statement of the Problem

The central role of vocabulary in reading comprehension has been documented for both native English speakers and ELLs (Baumann, Kame‘enui & Ash, 2003; Nagy, 2005; Proctor, Carlo, August & Snow, 2005, 2006). Yet comparative studies have concluded that the impact of vocabulary knowledge on reading comprehension is more dominant for ELLs than for native language speakers (Proctor et al., 2005, 2006; Verhoeven, 2000). More specifically, research has established that problems associated with understanding non-technical terms in science are greater than those that relate to technical vocabulary (Abdul-Hamid & Samuel, 2012, Cassels & Johnstone, 1983, 1985; Childs & O'Farrell, 2003; Cohen et al., 1979; Slater; 1978; Tao, 1994; Trimble, Trimble & Drobinic, 1978; Todd-Trimble, 1978). While the comprehension of these terms is problematic for both natives and Ells, studies have shown that the former have better understanding of these terms (Ali & Ismail, 2006; Bird & Welford 1995; Cassels, 1980; Childs & O'Farrell, 2003; Johnstone & Selepeng, 2001). These difficulties are compounded for ELLs since they have to learn the language of science while still developing their reading and literacy skills (Tong et al., 2014). Since the textbook remains the main source of information in science classes (Craig & Yore, 1996; Van de Broek, 2010), students who are unable to comprehend vocabulary from science texts are limited in their acquisition of content knowledge (Fang & Wei, 2010).

In the context of Lebanon, private schools offer a variety of programs including the Lebanese Baccalaureate program, International Baccalaureate program, French Baccalaureate program and the American program. Each of these programs requires the use of specialized books for each subject area. In the case of the Lebanese program, authors who are ELLs themselves are usually employed to develop textbooks for each subject matter. In contrast, programs such the International Baccalaureate and American program use textbooks issued by foreign publishing companies such as Houghton Mifflin Harcourt or Holt McDougal. According to the CERD website, 26 private schools in Lebanon offer the American program of which 15 schools (57%) are located in Beirut and Mount Lebanon area. Despite the prevalence of American science textbooks, no study has investigated ELLs' understanding of science texts in American textbooks.

Only one study conducted by Radwan (2013) investigated Lebanese elementary students' difficulties in understanding technical and non-technical terms. The study focused on terms found in Lebanese science textbooks. Given that these books are written by Lebanese authors, who themselves are ELLs, it is likely that the English language used is simplified, and possibly includes errors. Moreover, the author limited her study to Grade 6 and as a result a gap in knowledge exists on whether these difficulties persist for higher grade levels. Given the number of schools which offer the American program and knowing that their textbooks are written for students whose native language is English, it is significant to investigate whether middle school students enrolled in private schools will have similar or different problems in understanding non-technical terms found in American science textbooks.

The aim of this study is to investigate middle school students' comprehension of non-technical words since research has shown that such proficiency is crucial for the learning of science. The assessment of students' comprehension of content-area texts have mostly relied on the use of standardized tests (Taboada, 2012). Yet some argue that since these tests are general in nature, they add little to our understanding of reading comprehension especially how it relates to the use of specialized language and the required skills needed in each content area (Bailey, Huang, Shin, Farnsworth & Butler, 2007; Schleppegrell, 2001; Snow, 2002). In the last decade, commonly used standardized assessments that measure performance in reading comprehension include the Standardized Assessment Test (SAT). The SAT is a globally recognized college admissions test taken by junior and senior high school students which is predictive of students' Grade Point Average (GPA) and overall academic success (Bradley et al., 2004; Palin, 2001; Ramist, Lewis, Jenkins, 1997). Given the fact that the SAT is a high stakes test, many schools choose to prepare their students for the test by administering the Preliminary SAT (PSAT) either in Grade 10 (PSAT 10) or Grades 8 and 9 (PSAT 8/9). This study evaluates the value of using standardized test scores such as the PSAT as predictors of students' reading comprehension in science. More specifically, the study explores whether students' PSAT verbal reasoning scores are correlated with understanding of non-technical words in science. In other words, is the reliance on standardized test scores such as the PSAT useful to determine whether students are proficient in reading and understanding non-technical words in science?

Cassels and Johnstone (1985) found that the understanding of non-technical terms is associated with verbal reasoning skills. Given this finding, one study conducted in Britain by Pickergill and Lock (1991) investigated whether a correlation existed between students' understanding of non-technical terms in science and their scores on a verbal reasoning test and found a positive correlation between the two variables. Only one study conducted at the American University of Beirut, investigated the correlation between Arab ELLs' English Entrance Exam (EEE), Test of English as a Foreign Language (TOEFL) and verbal section of the SAT I scores and their biology final course grade (Dandashly, 2005). No other study in Lebanon has explored the relationship between PSAT scores and comprehension of non-technical words at the middle school level. Therefore, there is a gap in the literature on the correlation between middle school students' understanding of non-technical words and their performance in the critical reading section of the PSAT.

Moreover, studies investigating students' understanding of non-technical terms have revealed an improvement with student age (Cassels & Johnstone, 1985; Marshall & Gilmour, 1990). Cassels and Johnstone (1985) explored the understanding of 95 non-technical words with students in Britain ranging from grades 1 through 13. Results showed improved student understanding of terms with age. Similarly, Marshal and Gilmour (1990) found that students' performance on specified non-technical terms such as "partial" and "agent" improved between Grades 9 and 11. In the context of Lebanon, Dandashly (2005) found that university biology students demonstrated a better understanding of non-technical than technical terms. Although this study does not directly compare performance between age groups, it does show that by the time students reach university they become more familiar with non-technical terms. Given these results and the absence of research done in Lebanese middle school settings, it is significant to investigate whether this improvement is noted in middle school especially since language demands tend to become more challenging at this educational level (Lee et al., 2013).

Research Questions

Consequently, the purpose of this study is to identify the challenges faced by middle school English language learners in Lebanon when reading science texts. Specifically the study answered the following research questions:

1. To what extent do middle school students in a Lebanese school understand non-technical terms used in their American science textbooks?

2. Does ELLs' comprehension of non-technical words in a Lebanese middle school vary according to different contexts (one word synonym without a context, everyday context, science context and non-science context)?

3. What are the difficulties related to non-technical terms faced by ELLs in a Lebanese middle school when encountered in American science textbooks?

4. Does comprehension of non-technical words improve over middle school years?

5. In a Lebanese middle school, how does ELLs' comprehension of non-technical words in science context correlate with their PSAT critical reading scores?

Significance of the Study

From a research perspective, this study added to existing knowledge on middle school students' understanding of non-technical terms in science. More specifically, a better understanding of the sources of difficulty ELLs in Lebanon face when reading American science textbooks was reached, especially since these books are written for native speakers and not ELLs. This is significant since limited research that has been done in Lebanon has either focused on elementary students reading from local science books or on university students. Given that studies around the world have identified an improvement in student understanding of these terms with age, it is significant to explore whether this is the case in the Lebanese context. Furthermore, language demands tend to increase with each grade level (Lee et al., 2013) and as such it is expected that ELLs face even more difficulties understanding texts as they progress in middle school.

The sample in this study consists of not only of Lebanese ELLs but also of ELLs of diverse nationalities and backgrounds. After the recent political events in Arab countries, Lebanon has witnessed a huge influx of Arab students from various neighboring countries who have integrated in Lebanese private schools. This is significant since it is expected that these students have different levels of English language exposure which may affect their understanding of non-technical terms in science. A gap in the literature exists on the language difficulties faced by Arab ELLs in Lebanon where the language of instruction in science is not the native language. Results from this study can therefore contribute not only to the Lebanese context but also to the international literature on bilingual science education.

In the classroom, results of this study can help science teachers become more aware of the importance of language in the learning of science and become more attentive to clarifying non-technical words found in science textbooks. Science teachers can either work with English language teachers or assume that role themselves when explaining science texts. Furthermore, students who score well on their PSAT critical reading and writing tests are usually assumed to have adequate English language proficiency. Results from this study answered the question of whether these scores are useful indicators of students' abilities to understand non-technical terms in science. This will help teachers better identify students who struggle in understanding non-technical terms in science texts. On a larger scale, results from this study might help Lebanese and Arab science educators and policy makers effectively recognize and address the linguistic challenges of reading science texts in order to enhance Arab ELLs' science achievement. Results from this study might also stimulate future research on effective reading and science instructional strategies catering for this group.

CHAPTER II
LITERATURE REVIEW

The aim of this study is to investigate middle school ELLs' understanding of non-technical terms commonly encountered in an American science textbook. This review is divided into seven parts. The first discusses scientific literacy and reading in science while the second reviews the challenges of reading science texts. The third and fourth parts discuss native and ELLs' problems in understanding non-technical terms in science respectively, while the fifth part presents studies that compared the understanding of the two groups. The sixth part explores studies that describe relationships between standardized English tests and science performance while the final one summarizes studies which relate to students in the Arab world.

Scientific Literacy and Reading in Science

Scientific literacy as a goal of science education. Over the past few decades, the science education community has reached consensus on the need to enhance science literacy (Hand et al., 2001; Next Generation Science Standards Lead States, 2013; Osborne, 2002; Pearson et al., 2010; Reiss et al., 1999; UNESCO, 1994; Webb, 2010). UNESCO maintains that:

> Scientific and technological literacy is a universal requirement if people are not to be alienated to some degree from the society in which they live, if they are not to be overwhelmed and demoralized by change. (UNESCO, 1994)

Consequently, science education reforms in various countries, including those in Europe and the United States, (Deboer, 2000; Dillon, 2009; Eisenhart, Finkel & Marion, 1996; Hand et al., 2001) as well as curriculum standards and international comparisons of student achievements such as the Program for International Student Assessment (PISA) study focused on scientific literacy as a central issue (Dillon, 2009). Furthermore, major reform projects in the United States such as the National Science Education Standards (NSES) emphasized the need to establish scientific literacy for all students (NRC, 1996).

More recently, a group of 26 states developed the research-based Next Generation Science Standards (NGSS) (Next Generation Science Standards Lead States, 2013), which identified expectations for what K-12 students should know and do in science class. These standards were based on the National Research Council's (NRC, 2012) document titled *A Framework for K-12 Science Education: Practices, Crosscutting Concepts and Core Ideas*. The framework identified three dimensions for the learning of science - crosscutting concepts, science and engineering practices and disciplinary core ideas - which when integrated form standards that build students' proficiency in science. According to the NGSS, the aim of the practices dimension is to describe the activities performed while scientists explore the natural world, while crosscutting concepts allow students to explore connections across the domains of science. The disciplinary core ideas (DCI) are key ideas in science that assume broad importance across various science disciplines (Next Generation Science Standards Lead States, 2013). Throughout the frameworks document, emphasis is placed on student engagement in science practices as a means to develop scientific literacy because "science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend and refine that knowledge" (NRC, 2012, p. 26)

Fundamental and derived senses of scientific literacy. Reading and writing are not only ways in which science is performed and understanding is constructed but also ways in which knowledge is communicated to other people (Yore, Bisanz & Hand, 2003). A fundamental activity performed by scientists is establishing communication with others via reading and writing emails and research articles, participating in conferences, reading and evaluating information as well as engaging in argumentation (Next Generation Science Standards Lead States, 2013; Osborne, 2002; Pearson et al., 2010, Sutton, 1998). Research maintains that the achievement of scientific literacy is linked with the development of proficiencies in reading, writing, and reasoning with the language and texts of science (Fang, 2006; Pearson et al., 2010; Tong et al. 2014).

Much like the work of scientists, the practices described in the NGSS require that students spend a lot of time reading, writing and talking in science classrooms. Specifically, four of the eight practices involve student engagement in science discourse and the intensive use of language skills. These practices include: constructing explanations (practice 6), engaging in argumentation (practice 7), obtaining evaluating and communicating information (practice 8) and developing and using models (practice 2). For instance, prior to presenting their arguments and constructing their explanations, students prepare by reading, interpreting models as well as writing their own science texts. Later on, they engage in listening and verbalizing their understanding by using specific science terminology. Reading, writing and speaking are particularly central when obtaining evaluating and communicating information. Much like scientists, students are expected to read and extract meaning from science texts then communicate their understanding via written or spoken language (Lee, Quinn & Valedes, 2012; 2013).

Given the centrality of reading and writing in science activities, Norris and Phillips (2003) distinguished between two senses of scientific literacy: fundamental and derived. The fundamental sense involves being proficient in the discourse of science including writing, reading and talking science while the derived sense emphasizes knowledge of the conceptual themes of science (Norris & Phillips, 2003). Contrary to previous conceptions that either neglected the fundamental sense or portrayed reading and writing as mere tools for the storage and transmission of science, reading and writing take on a constitutive rather than a functional role in which they represent an essential component of science (Norris & Phillips, 2003). In this sense, much like the removal of experimentation, observation or measurement compromises the learning of science, the removal of reading or writing would also prevent proper science learning. Researchers guided by the fundamental sense maintain that students who are not proficient in making meaning of written scientific texts are limited in the depth of scientific knowledge they can acquire and consequently in the development of their derived sense of science literacy (Fang & Wei, 2010). Based on this conception, those students will not be able to participate in the science discourse as scientifically literate citizens (Pearson et al., 2010).

Reading to learn science. According to Wellington and Osborne (2001), reading has not been considered as a central part of the science classroom. The science education community instead focused on removing reading texts from science instruction because of the perception that it was a passive meaning making process (Norris & Phillips, 2003; Sutton, 1998; Yore, Craig & Maguire, 1998). This view defined successful reading as skilled word decoding and locating information in the text (Norris & Phillips, 2003). However, there are two distinct areas of reading: decoding of words and reading comprehension (McNamara, O'Reilly, Best & Ozuru, 2006). According to the RAND Reading Study Group (2002), reading comprehension is defined as “the process of simultaneously extracting and constructing meaning through interaction and involvement with written language” (p. 11).

Despite their proficiency in word decoding, many students face difficulties in making sense of words which appear as a series of familiar and unfamiliar words rather than a coherent and comprehensible message (Best et al., 2005). Haas and Flower (1998) found that even students categorized as good readers would resort to shallow responses such as recalling instead of interpreting and summarizing instead of criticizing. This problem especially evident at the middle and secondary school levels where students are regularly required to read and write in science (Lara-Alecio et al., 2012; Tong et al., 2014). While lower elementary grades focus on developing basic literacy skills such as word decoding (learning to read), students in higher-level grades are required to read to learn science (Fang & Wei, 2010, Lara-Alecio et al., 2012; Tong et al., 2014). At this stage, they are required to read content area texts in order to gain knowledge of academic subject matters while also developing their reading and writing skills (Fang, 2006).

Challenges of Reading Science Texts

Traditionally, language has been viewed as a tool for the transmission of information (Fang, 2005; Norris & Phillips, 2003). According to functional linguistics, language is a semiotic tool used to construct and organize human experiences (Halliday, 1978; Hasan & Martin, 1989). In this conception, each context requires different language choices and grammatical features in order to achieve the author's goal and to reach its social function (Fang, 2005). Based on this functional view, the language needed to convey science knowledge and reasoning is different from everyday language. The scientific method used to investigate the physical world has led to a form of scientific language that facilitates the communication, production and organization of scientific knowledge (Halliday, 1993; Schleppegrell, 2001; Sutton, 1998 Yore et al., 2004). This language has thus evolved from personal and informal talk to a more objective and definite language characterized by the use of specialized grammar and passive voice (Sutton, 1998). These features render science texts rigid, dense and more abstract than readings experienced in the early years of school (Fang, 2006; Sutton, 1998). Given the complexity of the language of science and the fact that textbooks are considered the primary source of information in science classes (Craig & Yore, 1996; Van de Broek, 2010), reading and understanding from science texts is the central challenge of acquiring scientific knowledge (Fang, 2005, 2006; Groves, 1995). In fact, Wellington and Osborne (2001) maintain that the biggest challenge to learning of science is the language of science itself.

School science texts have adopted properties of professional scientific writing (Fang, 2006; Gee, 2004; Halliday, 1993; Lee et al., 2008; Sutton, 1998). The following briefly describes features of the language of science in school textbooks which contribute to the difficulties of reading and understanding science.

Logical connectives. Logical connectives are words or phrases prevalent in science texts that are used to establish relationships between data (Gardner et al., 1976; Osborne, 2002) and are essential for creating logic within a text (Wellington & Osborne, 2001). Logical connectives are key to drawing conclusions, making inferences and identifying cause and effect relationships (Wellington & Osborne, 2001). Few studies have investigated student comprehension of logical connectives found in science texts. Gardner (1977) discusses the results of the Logical Connectives in Science Project which aimed to assemble a list of logical connectives in English as well as identify those that are found in high frequency in secondary school books. The project also aimed to investigate Australian students' understanding of these terms. The sample consisted of 16,530 Australian students ranging from Grades 7 through 10 enrolled in the state of Victoria. Each of the 180 logical connective chosen was tested at least four times: two types of multiple choice questions (gap filling and sentence completion) within a scientific and everyday context. Results indicated student difficulties with around 75 connectives which relate to inference, comparison and contrast as well as apposition and order. Furthermore, it was found that 10^{th}

grade students were able to correctly answer three quarter of the items on the test in comparison to just half of the items for seventh grade students indicating an improved understanding of the logical connectors with grade level. Another study conducted by Byrne, Johnstone & Pope (1994) partially replicated and extended Gardner's work by investigating 247 ninth grade students' understanding and reasoning of terms in both science and non-science contexts. Results indicated difficulties in understanding logical connectives when found in science contexts.

Information density. The information density of a text, measured by an index referred to as lexical density, can be calculated by determining the number of content words per embedded clause (Halliday, 1993) or as a percentage of content words over total number of words (Eggins, 2004). According to Halliday (1993), while oral speech and written texts have around two to three and four to six content words per clause, respectively, science texts can include up to 10-13 content words per clause. This translates to around 38 content words for a total of 68 words resulting in a lexical density of around 56%.

Nominalization and ellipsis. Nominalization involves a change in grammar from verbs or adjectives to nouns and noun phrases in order to facilitate the expression of generalizations and arguments, to classify and describe as well as synthesize and summarize previous knowledge (Fang, 2006; Fang & Schleppegrell, 2010; Halliday & Mathiessen, 2004; Martin & Rose, 2007). For instance, instead of using the phrase “the cell divides again and again”, it is expressed using abstract noun phrases such as “the process of cell division”. Texts containing a high density of abstract noun phrases make it difficult for students to comprehend sentences since nominalization tends to conceal meaning. Another problematic area is the use of ellipsis. Ellipsis is the omission of words, phrases or clauses. For the purpose of linguistic economy, texts often remove repetitive words in order to avoid redundancy. However, this causes confusion for readers who are in the process of developing their syntactic structures (Fang, 2006).

Technical and non-technical terms. Technicality in science texts is used to relay the specialized content and involves the use of technical vocabulary as well as verbs that show relational processes (Fang, 2005). Technical vocabulary includes terms that have a specialized subject-specific meaning (Eggins et al., 1993) and refers to physical objects or natural phenomena (e.g. asthma, metabolism, microorganism). They are often marked in bold and defined in science textbooks. The prevalence of technical terms within each sentence (around 1/3 of the total words) results in sentences that have high density of information (Fang, 2005, 2006). A study conducted by Hurd et al. (1981) investigated grades six through nine science textbooks and found that around 2,500 novel terms were introduced which, in comparison with other foreign language texts, is almost twice as much for the same grade levels. Similarly, Groves (1995) provided a measure of the vocabulary load in four secondary science textbooks. Results showed an elevated science vocabulary count that is considered higher than what is expected for the secondary level. The heavy emphasis on technical vocabulary in science textbooks raises the readability level above the intended grade level and hinders reading comprehension (Groves 1995; Wright 1982). In one study, Doidge (1997) investigated the readability of biology textbooks in South Africa and concluded that most were not accessible to students without extensive support from the instructor. Consequently, students tend to rely on memorization of terms which fosters the idea that the nature of science is static rather than dynamic and is linked with negative attitudes towards science (Songer & Linn, 1991).

In addition to the problems associated with the use of technical terms, non-technical words present an even greater source of reading difficulty (Cassels & Johnstone, 1983, 1985;

Clark, 1997; Slater, 1978). According to Cassels and Johnstone (1985), problems with the comprehension of technical terms are related to students' familiarity with the terms and students are able to cope with them fairly well. While technical words such as "pipette" and "cotyledon" have specific meanings, non-technical terms such as volatile might be associated with numerous meanings in non-scientific contexts such as hostile situations or unpredictable markets (Johnstone, 1991). As such, when reading science texts, a phrase such as "volatile compound" will not make sense to students. It is therefore common for teachers and students to have different understandings of the same non-technical word (Cassels & Johnstone, 1985; Johnstone, 1991; Johnstone & Selepeng, 2001). Students, who are proficient at decoding words, become frustrated since the meanings they have assigned to those terms prevent their understanding of the text (Fang, 2006).

Studies broadly define non-technical terms as terms with specialized meanings in science different from their vernacular sense (Childs & O' Farrell, 2003; Fang, 2006; Johnstone & Selepeng, 2001; Lee et al., 2008). More specifically, Cohen et al. (1979) differentiated between three categories of non-technical terms. The first includes terms which adopt a technical meaning in a specialized field such as the term "specific" in genetics which refers to the enzyme property of "specificity". Another category is terms which are used in contextual phrases such as "repair processes" in genetics. As mentioned earlier, science texts are characterized by the presence of high informational density for which writers are compelled to use various language tools (Fang, 2006). One such language tool is the use of phrases which paraphrase or summarize scientific concepts. For instance, "repair process" is a phrase used to summarize the process by which enzymes are used to repair mutations in the DNA in order to restore it to its original state. The final category includes terms which refer to time sequence or truth validity such as "initial", "final", "simultaneously" and "intermittently". Furthermore, Gardner (1972, 1976) explained that non-technical terms are simply terms that the instructor would not deliberately plan to explain in class. This is in contrast to technical terms that are purposefully included in the lesson plan and their meaning explicitly taught.

Around 30 years ago, Cassels and Johnstone (1985) described the problems associated with students' comprehension of non-technical words in science. Their study, conducted in the U.K., included British students ranging between the ages of 12 and 17. According to the authors, the intelligibility of a term is affected by the context in which it is placed. The study aimed to investigate students' understanding of 95 non-technical words in four contexts; one word synonym without a context, an everyday context, a non-science context and a science context. The one word synonym without a context format was similar to a dictionary since students were required to identify a correct synonym for each term without the assistance of a context. In the science contexts terms were placed in a science related stem. Both the everyday and non-science contexts were related to real life events yet assumed different purposes. On the one hand, the everyday context aimed to identify whether students confuse non-technical terms with other words that look or sound the same while, on the other, the non-science context aimed to establish whether students better understand terms in everyday contexts more than in science contexts (Cassels & Johnstone, 1985). The terms chosen were based on an earlier study conducted by Gardener (1972) who studied Australian students' understanding of 500 non-technical English words. Results of the Cassels and Johnstone (1985) study showed that students tend to assign opposite meanings to words as well choose words that look-alike or sound-alike. Furthermore, students were found to lack accuracy in identifying the meaning of words.

The following five sections discuss studies that have modified and elaborated on Cassels and Johnstone's (1985) study in order to investigate the challenges of reading and understanding non-technical words in science. Specifically, the first and second parts describe studies that relate to native English language speakers and ELLs respectively and the third part describes studies that compare the understanding of both groups. The fourth part illustrates the relationship between students' understanding of non-technical terms and their SAT scores while the final part discusses studies that relate to the Arab world.

Native English Language Speakers' Problems with Understanding Non-technical Words in Science

A study conducted by Pickersgill and Lock (1991) examined the understanding of 30 non-technical words used in science with a sample of 197 randomly selected students ranging between 14 to 15 year old whose native language was English. The study aimed to explore whether understanding of non-technical terms varied between genders and if it was correlated with students' verbal reasoning skills. It also aimed to investigate the specific challenges associated with non-technical words in science. Guided by the study conducted by Cassels and Johnstone (1985), four versions of a questionnaire were constructed each consisting of 30 questions related to non-technical words and 40 questions testing verbal reasoning. Results showed no significant difference between genders in understanding non-technical words in science. Consistent with Cassels and Johnstone (1985), it was revealed that students struggled with synonym type questions, confused look-alike and sound alike words and often identified opposite meanings to words. Results also showed that although the words tested were commonly used in science lessons, they were inaccessible to students. Furthermore, a positive correlation was found between students' scores on a verbal reasoning test and on their understanding of non-technical words in science.

Two studies conducted by Jaisen (2010, 2011) examined college students' understanding of non-technical words with multiple meanings in chemistry. Jaisen (2010) conducted interviews with 20 chemistry students to explore their understanding of the term "neutral" in chemistry. Although students were able to correctly interpret the colloquial meaning, the majority misinterpreted it and associated it with "unreactive" when given in the chemistry context. In the second study, Jaisen (2011) investigated 20 chemistry students' understanding of the term "strong" in chemistry. The majority of students correctly interpreted strong in the colloquial sense, however, when placed in a chemistry context 13 out of 20 students were unable to correctly describe the meaning of strong acid as "completely dissociated". It was also found that the chemical meaning was linked to "charge", "concentration" and "powerful".

O'Rafferty (1989) investigated Irish students' understanding of 40 non-technical terms used in science. These terms were compiled from a commonly used middle school science textbook and were compared with Cassels and Johnstone's (1985) "Words for Special Attention". A 40 item test was administered to 109 students in the first year and 80 in second year studying science in a post primary school in Ireland. Results indicated that around 30 percent of the chosen words were misunderstood. Contrary to other studies, it was found that comprehension of terms did not improve with age. Furthermore, students did not perform better on words which were previously explained in class.

English Language Learners' Problems with Understanding Non-technical Words in Science

Learning from science texts written in the English language is even more problematic for ELLs (Ali & Ismail, 2006; Bravo & Cervetti, 2014; Johnstone & Selepeng, 2001). These students face the dual challenge of understanding the specialized language of science in “a yet un-mastered language” (Lee, 2005 p. 492). The problem is further compounded when vocabulary discrepancies are found between English reading requirements and science texts for the same grade levels (MacDonald, 1990; Ryf & Cleghorn, 1997).

In their recent study conducted in Malaysia, Ali and Ismail (2006) investigated 91 students' comprehension of 25 non-technical terms used in science. The sample included university students from science, engineering and art majors who were instructed in English but whose first language was Malay. The survey included 50 multiple choice questions divided into two categories whereby one used the term in an ordinary everyday sentence and the second used it in a science context. Results showed difficulties in interpreting words such as "rate", "impact" and "composition". The most commonly misunderstood word was "substitute". Students' popular choice was to "bulk it up" instead of to "put in place of another". Furthermore, among the three streams, students in the science class demonstrated the highest level of comprehension. It was also found that ELLs who spoke English at home showed a higher comprehension of non-technical terms than those who did not.

In Malta, Farrell and Ventura (1998) examined the understanding of 50 non-technical and 25 technical physics words in English with a sample of 306 advanced level physics ELLs whose first language was Maltese. A two-part test was constructed to explore whether students who claim to know the meaning of these selected words have actually understood them. For the first part of the test, participants were required to identify whether they knew the meaning of the 75 terms by simply checking a yes or no box for each word. For the second part of the test, the terms under study were presented in sentences and students were required to provide meanings for each word. Results showed a low correlation between the claimed and actual comprehension of a majority of technical and non-technical terms indicating that students who claimed to know the meaning of terms didn’t really comprehend them. The authors found that non-technical words with various meanings such as "marked" were problematic. Other areas of difficulty were related to phonetic interference such as the confusion between "finite" and "fine" as well as "consistent" with "constant". The study also found that students often provided opposite meanings to terms such as defining the term "definite" as not 100% sure.

Also carried out within the same research framework, Marshall and Gilmour (1990) investigated the comprehension of 45 non-technical words frequently employed in physics classrooms in Papa New Guinea. The language situation in Papa New Guinea is made more complex with the existence of more than 700 languages. The sample consisted of 2,111 ELLs from Grade 7 up to university level who had been instructed in English. Each word was tested in four different contexts and formats which were then randomly distributed among four test papers. It was found that performance on only 11 out of the 45 words tested was satisfactory. Furthermore, students allocated opposite meanings for at least 8 words and when confused chose look alike and sound alike words. Although there was increased comprehension with age, common words such as "exert" and "random" were not understood by students from Grade 7 up till university level.

Similarly, Tao (1994) explored Hong Kong students' comprehension of non-technical words used in science with 4,644 secondary level students whose first language is Chinese but were instructed in English. Students answered a questionnaire which included a list of non-technical words used in physics, biology and chemistry in a variety of contexts. Results showed a poor understanding of the majority of non-technical terms. Similar to other studies, students also confused terms with look-alike and sound-alike words and often identified opposite meanings.

Studies Comparing the Command of Non-technical Terms Between Native English Speakers and ELLs

A few studies have compared native speakers' and non-native English language learners' comprehension of non-technical terms. The study conducted by Bird and Welford (1995) was one of those few studies. It aimed to investigate whether the simplification of the wording used in the General Certificate of Secondary Education (GCSE) and Cambridge General Certificate of Education (GCE) examinations would improve students' performances on the exams. Two samples were selected from the UK; the first was comprised of native English language speakers from the UK while the second consisted of ELLs from Botswana whose first language was not English. Results showed that revised tests did not influence the performance of UK students while a significant improvement was shown for the ELL sample. The authors concluded that word comprehension was of vital importance for enhanced achievement in the case of non-native English language speakers.

Another study conducted by Johnstone and Selepeng (2003) aimed to repeat Cassels and Johnstone's (1985) study on a smaller scale in order to evaluate whether the comprehension challenges persisted twenty years after the original study. The 2003 study was conducted in a

Scottish school which included both native English language learners as well ELLs. A sample of 25 words from the earlier study was selected for the multiple-choice test. Results showed a stronger understanding of terms for native language speakers in comparison to ELLs. Similar to the prior study, students chose opposite meanings and confused look alike and sound alike words. It was also found that difference between native and non-native English language speakers was still evident.

Also based on the work of Cassels and Johnstone (1985), Prophet and Towse (1999) investigated seventh- and eighth-grade ELLs in Botswana as well as seventh- and eighth-grade native English language speakers and ELLs in England. Researchers chose 25 non-technical words commonly found in science textbooks from both countries. Two tests were created: in one test, words were placed in a science context; in the other, words were not placed in any context. All participants were required to complete both tests. Results showed that students in England whose first language was English scored the highest on both tests followed by Bostwanian students and then ELLs from England.

Similarly, Childs and O'Farrell (2003) compared the comprehension of 90 non-technical terms among native and non-native English language learners. The sample included 758 students from nine international schools in Europe and Asia. Upon administering the Cassels and Johnstone (1985) tests, results indicated a gap between native and non-native language speakers, with the latter showing a deficit in their command of non-technical vocabulary.

Studies Investigating the Relation between Standardized English Scores and Understanding in Science

Standardized tests such as the SAT and the PSAT have been commonly used to assess students' reading comprehension skills (Taboada, 2012). However, given that these tests are general in nature, it is argued that their scores are not necessarily indicative of students' reading comprehension skills in content areas which involve specialized language such as science (Bailey et al., 2007; Schleppegrell, 2001; Snow, 2002). As such, one research question explored in this study is whether students' critical reading scores on the PSAT are linked with their proficiency in understanding non-technical words in science texts. Only two studies established a link between students' understanding of non-technical terms in science and their verbal reasoning skills. In Britain, Pickersgill and Lock (1991) investigated whether a relationship existed between students' understanding of non-technical terms in science and their reasoning ability skills. Similar to the Cassels and Johnstone's (1985) study, four questionnaires were prepared and distributed to students in Britain. Each questionnaire included questions on students' backgrounds, a test examining the understanding of 30 non-technical terms and a verbal reasoning test. Analysis of the results showed that there was a positive correlation between students' scores on the non-technical term test and on the verbal reasoning test.

Although the following studies do not explicitly discuss the link between the understanding of non-technical words and standardized tests, they do explore the relationship between the latter and students' general course grades. Given that the textbook is the main source of information for students (Craig & Yore, 1996; Van de Broek, 2010), a good course grade indirectly indicates that a student is able to learn and understand from the available text. One study explored the relation between language comprehension and performance in chemistry for university students enrolled in 3 general chemistry courses (Pyburn, Pazicni, Benassi & Tappin, 2013). Students' language comprehension ability was assessed using their SAT critical reading scores while their chemistry performance was measured with examinations designed by the American Chemical Society. Results showed a significant correlation between SAT scores and general chemistry performance. Bunce and Hutchinson (1993) obtained similar results and found a correlation between verbal SAT with academic achievement in college chemistry. Another earlier study conducted by Nist, Holschuh and Sharman (1995) aimed to identify the factors that affect the performance of undergraduate biology students. A total of 52 high and 57 low performers were selected to study factors such as their study habits, metacognitive and strategies used. It was found that students' SAT verbal scores were the most powerful predictor of their performance in the biology course. In Lebanon, only one study conducted at the American University of Beirut, investigated the correlation between Arab ELLs' English Entrance Exam (EEE), Test of English as a Foreign Language (TOEFL) and verbal section of the SAT I scores and their biology final course grade (Dandashly, 2005). A non-significant correlation was found with all cases except for that between TOEFL and biology scores. According to the author, one reason for the conflicting result is the small number of students taking each test.

Studies that Relate to Students in the Arab World

Very few studies have investigated the comprehension of non-technical words in Arab countries. Arden-Close (1993) investigated the language challenges faced by Omani university students during their chemistry lectures given in English. The authors recorded and transcribed the classes of three lecturers who had no prior experience teaching ELLs. Interviews were also conducted with the instructors before and after the lectures were done. Interestingly, although the lecturers knew that the level of instruction would be basic, they did not foresee the problems that would arise from using a second language. One of the lecturers was surprised to have to explain familiar words which he did not initially think would be a difficult to understand. In fact, one of the major issues reported from the interviews was that lecturers tended to replace difficult terms with synonyms which may have been better understood by students. For instance, the lecturer would substitute terms such as "malleable" and "ductile" with phrases such as "drawn into wires" and "beaten into shapes". However, according to the author, such changes will not help students improve their vocabulary since their knowledge of words remains at a basic level. Furthermore, students will likely face difficulties in their future readings since they would not be able to understand the terms used without the assistance of the teacher.

Two studies were identified pertaining to reading comprehension challenges in the context of Lebanon. A study conducted by Dandashly (2005) investigated the problems faced by university level Arab ELLs when reading biology textbooks. Participants included 51 Arab students enrolled in three biology courses at the American University of Beirut. The nationalities of the participants were Lebanese, Jordanian, Syrian and Saudi. Two methods of data collection were employed; the first involved asking students to read biology text, selected from the student's biology course, and identify lexical and syntactic problems while the second involved the use of semi-structured interviews. In order to analyze the syntactic problems, Halliday's (1994) framework was used while lexical problems were analyzed using Cohen et al.'s (1979) criteria. Furthermore, students' English entrance exams were compared to their biology course final grade. In terms of syntactic problems, results showed problems in understanding both simple and complex sentences as well as grammatical metaphors. They also faced problems with parataxis and hypotaxis as well as expansion and projection. In terms of lexical difficulties, students faced more difficulties in comprehending technical than non-technical terms.

A more recent study conducted by Radwan (2013) investigated the problems faced by elementary level Lebanese ELLs in reading science texts. Participants included 196 sixth-grade students from six private elementary schools in Lebanon. Data was collected from multiple choice tests and a grouping worksheet adapted from Cassels and Johnstone (1983). Furthermore, 20 students were randomly selected for semi-structured interviews. Results showed that less than 50 % of correct answers were selected on questions related to technical terms. It was also found that most technical words were challenging with most of these words belonging to physics or biology lessons. It was concluded that most problematic words were those with multiple meanings which relate to physics such as force or weight. The semi-structured interviews revealed that many words were misread. Students also found difficulty in relating technical words with scientific concepts which resulted in superficial understanding of concepts. Furthermore, students identified inaccurate meanings to non-technical terms when they were placed in the scientific contexts and others identified opposite meanings to non-technical words.

CHAPTER III
METHODOLOGY

Research Design

The aim of this study was to investigate the difficulties associated with middle school students' understanding of non-technical words in science and to explore whether a relationship exists between students' PSAT scores and their understanding of non-technical words. Few studies have investigated the situation in Lebanon which have so far concentrated on either elementary or university level students. Furthermore, at the school level, focus has been on locally published books rather than American textbooks written for native speakers of English. Given the gap in the knowledge at the middle school level, there is a need to explore the difficulties associated with understanding non-technical words in the middle school Lebanese context.

To answer the research questions, the study followed a descriptive research design. A mixed method design was adopted where questionnaires and semi-structured interviews were used to collect data. This chapter includes four parts: information about participants, instruments used as well as data collection and data analysis procedures.

Participants

Sample. For convenience, participants in the study were selected from one Lebanese private school in Beirut that offers the American program and that utilizes American published science textbooks at the middle school level. This school caters for students who belong to middle and high socio economic status groups. Students who were native English language speakers were excluded from the study. Instead, the sample included middle school students (ranging between Grade 6 and Grade 9) whose native language was Arabic and who fit the profile of being ELLs. It is worth mentioning that contrary to the majority of Lebanese schools, the school under study classifies Grade 6 as part of middle school. The sample included a total of 167 students who fit the criteria mentioned.

Sampling procedure. Convenience sampling procedures were followed in this study. The researcher worked at the school and was knowledgeable of its policies and procedures which facilitated the data collection process. In addition, the school met the two criteria for inclusion. First, it used Science Fusion textbooks, a comprehensive K-8 science program, which is a trademark of the American educational and trade publisher Houghton Mifflin Harcourt. This series was used in the school starting from the elementary level up till ninth grade in middle school. Furthermore, most of the students enrolled were ELLs of various nationalities.

The total sample originally consisted of 199 middle school students. This number was then reduced to 185 since 14 students did not submit the signed parental consent form required by the Institutional Review Board at AUB. In order to identify ELLs whose first language was Arabic, a demographic questionnaire (described below) was distributed. Within the questionnaire, questions related to language preferences at home and in school were used to group students based on their language profiles. Four categories were identified: preference of using English, Arabic, mix of English and Arabic or other languages (such as Dutch, Spanish and Portuguese). Only ELLs whose first language was Arabic and who expressed preferences of using English, Arabic or both were included in the study. From the remaining 185 students, 18 students did not fit the above criteria and this resulted in a further reduction in the sample to 167 students.

Instruments

Students were required to answer a questionnaire consisting of two parts: demographics section (Appendix I) and non-technical vocabulary test (Appendix II).

Demographics. This section required students to provide some demographic information such as age, nationality and language practices and preferences. The researcher used this data to first identify students whose second language was English and then to categorize these students based on their language profiles. ELLs whose first language was Arabic and who preferred to use English, Arabic or both with family and friends were included in the study. Information obtained from the questionnaire was kept confidential.

Non-technical vocabulary test. In order to examine ELLs' understanding of commonly encountered non-technical terms, test questions corresponding to each term were adapted from the Cassels and Johnstone (1985) study. In their study, the authors investigated 30,000 British students' comprehension of 95 problematic non-technical words each used in four contexts: one word synonym without a context, every day, a science and non-science contexts. In their study, two packages (A and B) were prepared each testing the understanding of 45 non-technical terms. Within each package, four test versions (Pink, Green, Blue and Yellow) were constructed. Each version included a multiple choice item corresponding to one technical term in one of the four contexts. The contexts were randomly scrambled across the four test versions. Table 1 below provides a description of each context as well as a sample item.

The Science Fusion series used in the school includes 11 books named Modules A through K. The following are examples of the modules used: "The human body"," Motion, Forces and Energy"," Ecology and the Environment" and "Cells and Heredity". The modules combined discuss numerous branches of science including biology, physics, earth science, space science, ecology and chemistry. Each module is used numerous times throughout middle school. For instance, Module H (Matter and Energy) is used from Grade 6 through Grade 9 while Module A (Cells and Heredity) is used in Grades 8 and 9. In other words, depending on the curriculum design, the same books are re-used in consecutive or intermittent years. Out the 11 books in the Science Fusion series, the middle school science curriculum requires the use of nine books (Modules A, B, C, D, E, F, H, I & K). These books were therefore selected to identify whether any of the 95 non-technical terms identified by Cassels and Johnstone (1985) were found. Using an online version of the books, the researcher identified 50 out of the 95 problematic terms which appeared multiple times throughout the modules (see Appendix III).

Similar to the Cassels and Johnstone (1985) study, four tests (Pink, Green, Blue and Yellow) were prepared each investigating the understanding of 50 non-technical words identified from the list of 95 most problematic terms. Each test included the non-technical word in one of the four contexts mentioned earlier. Much like the Cassels and Johnstone (1985) study, the four contexts were randomly scrambled across the four test versions. In order to fit the Lebanese context, test questions were subjected to modifications such as changing unfamiliar locations (Burj Khalifa instead of Ben Nevis) and words ("builder" instead of "joiner," "correct" instead of "sound"). Furthermore, similar to the Cassels and Johnstone (1985) study, five common questions were added to the beginning of each test each of which assesses student understanding in one of the four contexts. The aim of these identical test items was to insure the random distribution of the tests among the sample. In other words, analysis of these terms should reveal no relationship between the test version received and students' performance. The four tests were randomly distributed to middle school students ranging between Grade 6 and Grade 9 who submitted a signed parental consent form.

Semi-structured interviews. Semi-structured interviews with selected students were conducted to validate the findings from the non-technical tests and to further clarify student answers. The researcher first analyzed the questionnaire responses and identified high frequency errors and common challenges. High frequency errors were defined as responses on test items which more than 50% of the sample answered incorrectly. Five middle school students were selected for semi-structured interviews based on them having made these errors. The criterion for selecting these students was not made public; instead students were told that they were randomly selected to participate in the interview. Interview questions aimed to further understand student challenges by asking them to explain the meaning of certain terms and to include them in sentences. Students were also asked to explain the reason for their choices. The interview questions are presented in appendix IV. The interviews were audiotaped and transcribed. In the case in which parents refused audiotaping the interview, handwritten notes were taken instead.

Data Collection Procedures

After receiving IRB approval, the researcher obtained permission from the school principal to approach students, introduce them to the project and distribute the consent forms to be given to parents. Upon getting approval, all middle school students were approached in order to insure that all students were given the opportunity to participate if they wish and for their parents to provide consent. Students were then introduced to the purpose of the study and general information regarding their rights and expectations during data collection.

Table 1.

Description and Sample Item for each Context

Context	Description	Sample Item
One word synonym without a context	The word appears in a dictionary like format where four possible synonyms are presented in the absence of a context	The word "contrast" means a) To compare so as to point out differences b) To make or become smaller c) To grasp by understanding d) To plan what to do
Everyday context	The context relates to real life events. The word appears in four everyday situations only one of which is correct. The purpose of such questions is to identify if students confuse the term with words that look or sound the same	Which sentence uses the word "contrast" correctly? a) The painter used the black next to the white as a contrast b) The contrast lines on the map show where the hills are c) Many short stories were contrasted to make the book d) As the metal cooled rapidly it was seen to contrast
Science context	The word appears in a science context stem. The purpose of such questions is to identify if students understand the meaning of the term in science	By organizing the results of the experiment, the student was able to contrast between the types of substances. This means the student was able to a) Point out differences b) Point out similarities c) Identify patterns d) Identify substances
Non-science context	The context also relates to real life events. The word appears in a non-science context stem. The purpose of such questions is to identify if students understand the everyday meaning of the term	The colors were a contrast to each other. This means that a) Were unlike each other b) Were of similar shade c) Had the same brightness d) Varied in their texture

They were assured that their answers will be confidential and will not be part of their school assessment. They were also informed that they can stop and withdraw at any time.

Students then received consent forms to be shared with their parents or legal guardians. Consent forms were not collected by the researcher or any other teacher instead the floor supervisor took on this task. This was to insure that the anonymity of participants was maintained by making sure that both the researcher and teachers of any given class will not know who volunteered to participate in the study. Students whose parents gave consent about their participation were asked to complete the questionnaire. Student names were not on the questionnaire; instead, a coding system was used. A separate list with the names and corresponding codes was stored separately from the questionnaire. Students randomly received one of the four tests on non-technical vocabulary and completed it during one 50 minute science class. In order to avoid any perceived coercion, the researcher and other science teachers were not present when the questionnaire was administered and students were told that their teacher will not know who volunteered. Students completing the questionnaire were compensated for the missed class hour the following day during an allocated free period. Questions were not allowed and students were instructed to complete all items in the test. Based on the demographics information provided, only those that fit the language profile were included in the study.

The researcher then analyzed the test responses and identified high frequency errors and common challenges. Five middle school students were randomly selected for semi-structured interviews based on them having made high frequency errors as well as having given consent to participate in the interviews. The principal was first informed about the names of the students selected for the interviews. The school then provided an appropriate date and time for students to meet with the researcher who conducted the interview in a private meeting room at the school. The head of section informed each selected student of the date, time and location of the meeting. Each interview was conducted during one 50 minute class period. Each student was assigned a pseudonym in order to protect his/her privacy and anonymity. Students were informed about the purpose of the interviews and were reminded that their answers would remain confidential and that they can skip questions or withdraw from the interview at any time. The purpose of audiotaping the interviews was also clarified. Students were asked to explain the reasoning for their choices on selected questions. They were also asked to construct sentences using selected non-technical terms and to explain the meaning of certain terms in a specific context. The audio recording of the interview was transcribed for later analysis. The transcript was labeled using the student code; the student's name did not appear on the transcript.

Data Analysis Procedures

In order to identify if differences in performance between participants was dependent on the test version (pink, blue, green and yellow) they received, the researcher first compared the performance on the five common words at the beginning of each test using chi-square test. To analyze the performance on the 50 non-technical terms, the test items were first unscrambled back into four formats (one word synonym without a context, four everyday situations with only one that is correct, a science context and a non-science context). Students' responses on each of the items was classified as correct, incorrect or no response. The following analysis procedure was adopted from Marshall and Gilmour (1991) and was modified to fit the current study. The first research question examines the extent of middle school ELLs' understanding of non-technical terms found in the science textbooks. First, the overall correct, incorrect and no response scores were calculated for the whole sample. Then the overall percentage of correct responses for each language profile as well as each non-technical term was calculated. Terms for which less than 50% of the overall responses were correct were labeled as “problematic” terms. The second research question aims to investigate ELLs' comprehension of problematic non-technical terms across contexts. Following the identification of the problematic terms, the percentages of correct responses were identified for the sample's overall performance in each context and for each problematic term in each of the four contexts. In addition to analyzing the frequency of correct responses, the percentages of responses of each of the three remaining distractors were also obtained and analyzed (third research question). In order to answer the fourth research question, the percentages of correct responses were calculated for the following: the overall performance in each grade, differences in performance from grade to grade and differences in performance in each context from grade to grade. An additional analysis was conducted to identify whether any patterns exist for changes in understanding of terms with age.

Eighth- and ninth-grade students' PSAT critical reading scores were collected from the school administration. A correlation test was conducted in order to evaluate whether a relationship exists between students' comprehension of non-technical words and their PSAT scores (fifth research question). Furthermore, a linear regression was run to identify whether PSAT scores can predict students' total scores on the non-technical term test. Furthermore, constant comparative method was used to analyze data collected from student interviews. Specifically, open coding method was used to identify categories of mistakes and reasons for choices of incorrect items.

CHAPTER IV
RESULTS

This chapter reports on middle school students' comprehension of non-technical words found in American science textbooks. The results are obtained from analyzing students' responses on both the questionnaire and the semi-structured interviews. The first part presents an analysis of the first five common terms at the beginning of each test. Each of the parts that follow answers one research question presented in the study. As such, the second part reports on the extent of ELLs' understanding of non-technical terms (first research question), the third part reports on whether comprehension of non-technical words varies according to context (second research question) and the fourth describes the sources of difficulty that ELLs face when encountering non-technical terms in American science textbooks. The fifth part answers question related to whether improvements in comprehension of non-technical words are evident with age (fourth research question) and the last part explores the relationship between comprehension and PSAT scores (fifth research question).

Analysis of Stability of Performance across Tests

In addition to the 50 non-technical terms, five identical questions were added to the beginning of each of the four versions (Pink, Blue, Green and Yellow) of the questionnaire (see Appendix II). Similar to the study conducted by Cassels and Johnstone (1985), the aim of these five non-technical terms was to identify whether differences in performance between participants was dependent on the test version (pink, blue, green and yellow) they received. In other words, the expectation was that performance on these common items would be similar across the test versions. This indicates that any variations in students' performance on the remaining 50 non-technical terms was not due to the test version received rather due to differences in language skills. The stability of students' performance across tests also shows that differences in performance are not linked to other factors such as clarity of instructions or time of day during which the test was administered.

Five Chi-square tests were conducted to study the relationships between test versions (pink, blue, green and yellow) and students' performance (correct or incorrect response) on the five common non-technical terms. For the term "percentage", the chi-square test revealed that there was a significant relationship between test version and student performance; X^2 (3) = 8.40, p = .038. By looking at the percentages of correct/incorrect responses across the four test versions, it is evident that for the pink test, approximately equal percentages of participants had correct (48.8%) and incorrect responses (51.2%); however in the other three test versions, the percentages of correct responses (63.2% in blue, 76.7% in green and 65.0% in yellow) were higher than that of incorrect responses (see Table 2). Two reasons could explain this result; one is that the conditions of the pink test were somewhat different while another is that the term "percentage" is a slightly more difficult word (especially for lower middle school students who haven’t been adequately exposed to the term both inside and outside school). However, the chi-square tests revealed that there were no significant relationships between test version and students' performances on the second, third, fourth and fifth terms (Excite, Capable, Rebel, Average); X^2 (3) = 2.43, p = .49, *ns*; X^2 (3) = 1.59, p = .66, *ns*; X^2 (3) = 1.87, p = .60, *ns*, and X^2 (3) = 0.14, p = .99, *ns*, respectively. Since there were no differences identified in the other terms, it was judged that the conditions across the different versions were sufficiently stable to proceed with further analysis. Similar to Cassels and Johnstone (1985), these findings indicate that there was no significant association between test version and performance (except in the case of the term "percentage") and that individuals were responding in a similar manner across the versions of the test. In other words, difference in student performance on the remaining 50 non-technical terms was not due to sampling of the test version rather due to differences in understanding the non-technical terms examined. Table 3 shows the percentages of correct responses for the first five terms per test version.

Table 2.

Overall Performance on the Term "percentage" Across each Test Version

	Correct		Incorrect	
	N	%	N	%
Pink	21	48.80	22	51.20
Blue	24	63.20	14	36.80
Green	33	76.70	10	23.30
Yellow	33	71.80	11	28.20

Table 3.

Percentage of Correct Responses for the First Five Terms per Test Version

	Pink Test		Blue Test		Green Test		Yellow Test	
	N	%	N	%	N	%	N	%
Percentage	21	48.80	24	63.20	33	76.70	28	71.80
Excite	37	82.20	30	78.90	29	69.00	31	79.50
Capable	32	71.10	31	79.50	33	76.70	32	82.10
Repel	28	62.20	25	65.80	24	57.10	19	51.40
Average	37	80.40	32	82.10	35	81.40	30	78.90

First Research Question: The Extent of ELLs' Comprehension of Non-technical Terms

Overall performance of the sample tested. Total correct, incorrect and “no response” scores were calculated for all 167 participants. Across the sample as a whole, the average number of correct responses (out of 50) was 25.51 (SD=9.19), the average number of incorrect responses was 23.95 (SD=9.24) and the average number of no responses was 0.54 (SD = 2.21). The frequency distribution of the percentage of correct responses on the 50 non-technical terms is presented in Figure 1.

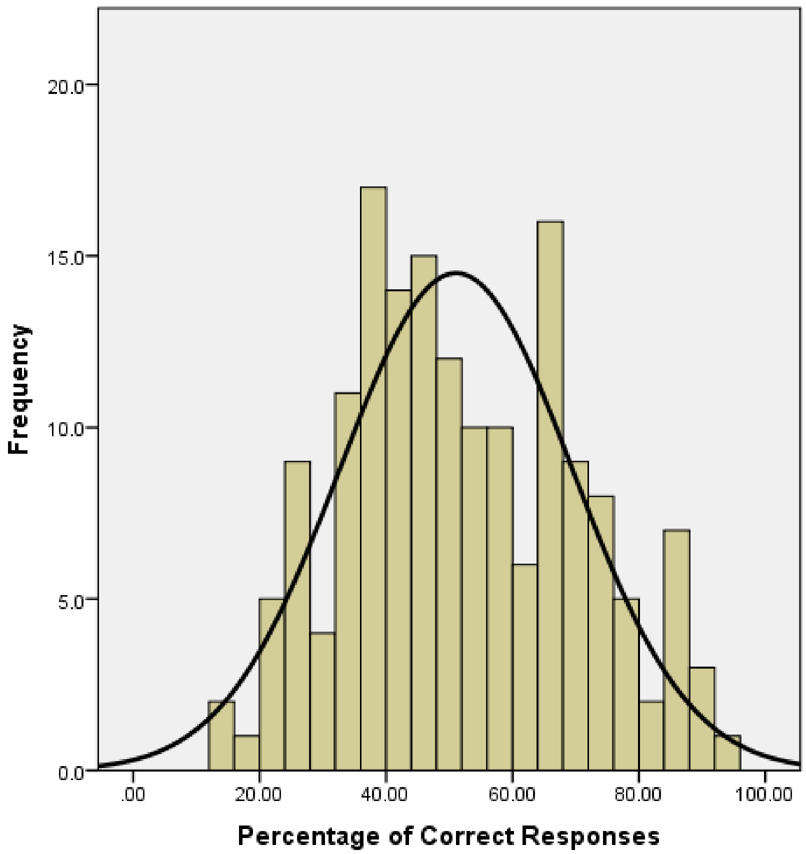

Figure 1: Frequency distribution of the number of participants responding correctly to some percentage of the 50 non-technical terms assessed.

Participants' overall performance was also analyzed based on their language profile. According to the data obtained from the demographic section, ELLs were categorized as having one of three language profiles; those who prefer to use Arabic, English or a mix of both languages with family and friends. Participants who preferred to use English achieved a higher total percentage of correct response (58.78%) in comparison to the other language groups suggesting that their understanding of these terms was better. Table 4 shows the percentage of correct response for each language profile.

Table 4.
Percentage of Correct Response per Language Profile

	Arabic with family and friends (N=68)	English with family and friends (N=23)	Mix of English and Arabic with family and friends (N=76)
Percentage correct response	47.80	58.78	52.08

Overall performance on each non-technical term. Analysis was first conducted on the sample's overall performance on each non-technical term. The total percentage of correct response for each of the 50 terms across all contexts and in the whole sample was first obtained (see Table 5). Results revealed that 30 out of the 50 non-technical terms (60 % of the non-technical terms) were categorized as problematic (see Table 7). Problematic terms were defined as terms for which less than 50% of the responses were correct. For the remaining analysis, the focus of the investigation was on the 30 problematic terms. One reason is that the majority of students demonstrated overall strong performances on these terms (more than 50% correct response) as well as strong performances in each of the four contexts (more than 50% correct response). Furthermore, a series of analysis was constructed that tries to identify sources of difficulty faced by students in understanding these terms (third research question) as well as differences in comprehension with age (fourth research question) and so this more detailed analysis requires the researcher to focus on a particularly problematic subset of words assessed.

Table 5.

Percentages of Correct Responses by Term in Ascending Order

Non-technical terms	Percentage Correct
Probability	32.90
Devise	34.10
Reference	37.10
Theory	37.10
Valid	37.10
Stimulate	38.90
Converge	39.50
Standard	39.50
Disperse	40.10
Factor	41.30
Relative	41.90
Symmetrical	41.90
Emit	43.10
Exert	43.10
Relevant	43.10
Diagnose	44.30
Rate	44.30
Efficient	45.50
Impact	45.50
Estimate	46.70
Initial	46.70
Source	46.70
Linear	47.30
Sequence	47.30
Classify	47.90
System	47.90
Influence	48.50
Excess	49.10
Device	49.70
Agent	49.70
Interpret	50.30
Composition	50.90
Illustrate	52.10
Substitute	54.50
Diversity	55.70
Contribute	56.30
Complex	60.50
Generate	61.10
Logic	61.10
Characteristic	61.70
Contrast	64.10

Table 5 continued

Non-technical terms	Percentage Correct
Essential	64.10
Effect	65.90
External	65.90
Detect	66.50
Limit	68.90
Concept	70.10
Components	70.70
Negative	71.90
Appropriate	80.80

Second Research Question: ELLs' Comprehension of Problematic Non-technical Terms across Contexts

The second research question investigates whether ELL's comprehension of problematic non-technical terms varies when found in different contexts. Each non-technical term was placed in four contexts: one word synonym without a context, an everyday context, a non-science and a science context. The test versions (pink, blue, green and yellow) examined the comprehension of the same non-technical terms in one of the four contexts. Analysis was first conducted on the overall performance of students on each 50 non-technical term. Terms for which less than 50 % of the responses were correct were labeled as problematic and were included in later analysis. The analysis procedure of Marshall and Gilmour (1990) were followed and modified to fit the study. The following sections report on the sample's overall performance in each context and the students' performance on each problematic term in each context.

Overall performance in each context. In order to evaluate whether participants' performance varied according to the context in which the problematic non-technical terms were found, the total percentage of correct answers in each context was obtained for the whole sample (see Table 6). Just as terms were identified as problematic, problematic contexts were defined as contexts in which the percentage of correct response was less than 50 percent. Analysis of the data revealed that participants' performance was weakest when problematic non-technical terms were found in the synonym context (40.19 % correct response) and strongest in the non-science context (46.92 % correct response).

A repeated measures ANOVA was conducted to study the relationship between context and percentage of correct responses. Before conducting the main analysis, the assumption of sphericity was checked. The Mauchly's test of sphericity revealed that the assumption of sphericity was met; Mauchly's W = 0.96, X^2 (5) = 6.29, p = .28, ns. The repeated measures ANOVA revealed that there was no significant relation between context and percentage of correct responses; F (3, 498) = 1.77, p = .15, ns.

Table 6
Percentage of Correct Response per Context for the Whole Sample

	Synonym Context	Everyday Context	Science Context	Non-science Context
Percentage correct response	40.19	41.89	45.21	46.92

Performance of problematic terms in each context. The percentages of correct responses for each of the problematic terms across the four contexts are included in Table 7. Within each context, terms were identified as problematic if participants achieved less than 50 % correct responses. Analysis of the results shows that in some cases, these terms were more problematic when found in specific contexts. Analysis also showed that terms were problematic in more than one context. For instance, three (10%) of the problematic non-technical terms were challenging in four out of the four contexts (see Table 8), 14 terms (47%) were problematic across three out of the four contexts (see Table 9), while 12 terms (40%) were problematic across two out of the four contexts (see Table 10).

Table 7

Percentage of Correct Responses Within Each Context for Each Problematic Term

Problematic Term	Synonym Context	Everyday Context	Science Context	Non-science Context
Classify	34.20	60.50	19.60	82.10
Device	60.50	39.50	48.70	50.00
Diagnose	17.90	37.00	52.60	67.40
Emit	42.10	34.90	32.60	66.70
Estimate	19.60	38.50	65.10	65.80
Exert	32.60	39.50	79.50	34.80
Agent	46.20	50.00	52.60	51.20
Converge	28.20	26.10	52.60	51.20
Devise	38.50	23.90	44.70	32.60
Disperse	39.50	34.90	41.30	46.20
Efficient	52.60	48.80	39.10	41.00
Excess	46.20	41.30	39.50	67.40
Factors	28.20	43.50	31.60	58.10
Impact	25.60	60.50	56.40	43.50
Influence	69.20	34.80	65.80	30.20
Initial	47.40	65.10	41.30	30.80
Linear	69.20	32.60	34.20	53.50
Probability	12.80	41.30	60.50	16.30
Rate	42.10	46.50	32.60	56.40
Reference	43.50	17.90	34.90	52.60
Relative	41.90	36.80	35.90	52.20
Relevant	51.20	50.00	46.20	28.30
Sequence	23.70	58.10	43.50	61.50
Source	45.70	25.60	53.50	60.50
Standard	16.30	60.50	38.50	45.70
Stimulate	37.20	31.60	56.40	32.60
Symmetrical	61.50	39.10	36.80	32.60
System	60.50	53.50	41.30	35.90
Theory	43.50	41.00	25.60	39.50
Valid	28.30	43.60	53.50	21.10

Table 8

Percentage of Correct Responses for Terms Weak in Four Contexts

Problematic Term	Synonym Context	Everyday Context	Science Context	Non-science Context
Devise	38.50	23.90	44.70	32.60
Disperse	39.50	34.90	41.30	46.20
Theory	43.50	41.00	25.60	39.50

Table 9

Percentage of Correct Responses for Terms Weak in Three Contexts

Problematic Term	Synonym Context	Everyday Context	Science Context	Non-science Context
Emit	42.10	34.90	32.60	66.70
Exert	32.60	39.50	79.50	34.80
Efficient	52.60	48.80	39.10	41.00
Excess	46.20	41.30	39.50	67.40
Factors	28.20	43.50	31.60	58.10
Initial	47.40	65.10	41.30	30.80
Probability	12.80	41.30	60.50	16.30
Rate	42.10	46.50	32.60	56.40
Reference	43.50	17.90	34.90	52.60
Relative	41.90	36.80	35.90	52.20
Standard	16.30	60.50	38.50	45.70
Stimulate	37.20	31.60	56.40	32.60
Symmetrical	61.50	39.10	36.80	32.60
Valid	28.30	43.60	53.50	21.10

Table 10

Percentage of Correct Responses for Terms Weak in Two Contexts

Problematic Term	Synonym Context	Everyday Context	Science Context	Non-science Context
Classify	34.20	60.50	19.60	82.10
Device	60.50	39.50	48.70	50.00
Diagnose	17.90	37.00	52.60	67.40
Estimate	19.60	38.50	65.10	65.80
Converge	28.20	26.10	52.60	51.20
Impact	25.60	60.50	56.40	43.50
Influence	69.20	34.80	65.80	30.20
Linear	69.20	32.60	34.20	53.50

Table 10 continued

Problematic Term	Synonym Context	Everyday Context	Science Context	Non-science Context
Relevant	51.20	50.00	46.20	28.30
Sequence	23.70	58.10	43.50	61.50
Source	45.70	25.60	53.50	60.50
System	60.50	53.50	41.30	35.90

In general, results showed that the majority of frequently encountered non-technical terms were not accessible to the participants in this study. In fact, out of 50 non-technical terms, less than 50% of participant responses were correct for 30 of these terms. These 30 terms were labeled as problematic and were the focus of the analysis. Further analysis revealed that students' overall performance on these problematic terms across the four contexts was weak. In general, performance was almost equally poor in the synonym and everyday contexts and slightly improved in the science and non-science contexts. Despite these results, some terms were found to be specifically weak in two out of four contexts, others in three out of four and a few in all four contexts.

Third Research Question: Sources of Difficulty Related to Non-technical terms

The third research question aims to identify sources of difficulty related to non-technical terms encountered in American science textbooks. For each context, in addition to analyzing the frequency of correct responses, the percentages of responses of each of the three remaining distractors were also obtained. The aim was to identify the most frequently chosen distractor for each question to examine sources of difficulty faced in understanding these terms. Semi-structured interviews were also analyzed to further clarify participants' sources of difficulty. Analyses of the sources of difficulty are organized in terms of problematic words across four, three and two contexts.

Terms problematic in four contexts. Results showed that three terms were problematic in all four contexts (see Table 8). For the term "devise" placed in an everyday context, the majority of students who answered incorrectly (30.40%) confused the term with "unwise" (a word that sounds the same). Analysis of the commonly chosen distractors also revealed that 20.50% defined it as "do" in the science context, while 44.20% identified it as "make" in the non-science context. In both of these contexts, students assigned imprecise meanings to the term. As for the synonym context, 28.20% of participants associated the term with "keep in". Furthermore, four out of five students interviewed confused "devise" with "device" (a look-alike and sound-alike word) and defined it as an appliance, tool or a machine. In fact, one participant gave the following sentence: "There are many devises used to measure different elements of weather ".

Participants also struggled with the term "disperse" especially in the everyday context where analysis of the most commonly chosen distractor (25.60%) showed that students tend to confuse "disperse" with "disuse" (a word that looks the same). Similarly, in the synonym context, most students who answered incorrectly (25.60%) confused the term with "collect" (a word with opposite meaning). While in the science and non-science contexts, analysis of the most commonly chosen distractors (26.10% and 23.10% respectively) showed that students confused the term with "bright" and " cause no trouble". Furthermore, four out of the five participants interviewed were unable to define the term.

As for the word "theory", participants confused the term with "fact" when found in all four contexts. This finding was especially evident in the science and non-science contexts where the majority of the participants who answered incorrectly (37.20% and 30.80% respectively) chose the distractor related to the word "fact". Similar findings were observed during the interviews where one participant provided the following sentence: "It is a theory that the Earth is round" while another participant defined it as "something that we think will happen".

Terms problematic in three contexts. Results revealed that 14 out of the 30 terms were problematic in three contexts (see Table 9). An analysis of the distractors showed that in the synonym and non-science contexts, 62.80 % and 1.80% of participants, respectively, defined the term as "possibility" (imprecise meaning). While in the everyday context, 21.70% of participants confused the term with words that look and sound the same such as “liability” and “probation.” Furthermore, during the interviews, when asked to explain the meaning of the term, one participant linked it with math class and explained that "it is a number between 0 and 1".

Similarly, participants found the term "factor" most challenging in the synonym context where 30.40% of students confused it with "structure"(a word that sounds the same). Results also showed that in the science context, the majority of participants (43.60%) confused the term with "system". Furthermore, in the everyday context, 28.30% of participants confused the term "factor" with "fraction" (a word that looks the same). Two out of five participants interviewed linked the term with mathematics explaining that "it is used in simplification" and "it is a number".

The majority of the participants (43.60%) also confused the term "initial" with "important" in the non-science context while 30.40% defined it as "careful" in the science context. Moreover, when found in the synonym context, 20.50% identified the term as "final" (opposite meaning). This confusion was also seen in the interviews where one participant provided the following sentence: "When I traveled the initial thing I did was pack my bag". When asked to clarify if it was a beginning or final step, the participant said it was the last thing he did.

As for the term "reference", participants' performance was especially weak in the everyday context. In that context, 38.50% of students confused the term with "refer" (a word that looks the same). The confusion was also evident in the science context where 32.60% of participants misinterpreted the term as "copying down". Some participants (19.60%) also defined the term as "reason" when it was placed in the synonym context. Furthermore, during the interview, one student related the word to "difference" (a word that looks or sounds the same) and provided the following sentence: "What is the reference between water and fire?" The term "valid" was also problematic especially in the non-science contexts where the majority of the participants (38.50%) lacked precision and confused it with "true". In the synonym context, 28.30 % of participants defined the term as "worthy" while in the everyday context, 25.60% identified it "valorous" (a word that looks or sounds the same). Furthermore, during the interviews, one participant linked it with an expiration date while another defined it as "something with value".

Participants' performance was also weak when the term "standard" was placed in the synonym context. In that context, the majority of students (34.90%) confused the term with "point of view". Furthermore, 33.30% and 23.90% of students respectively defined the term as "not ready to be used" (imprecise meaning) when it was found in the science and non-science contexts. One participant who was interviewed also defined the term as "something that stays the same". As for the term "stimulate", results showed that the majority of participants (35.90%) chose words that have opposite meaning such as "block" when the term was placed in the everyday context. Similarly, 21.70% of participants confused the term with "stop" when it was placed in a non-science context. While in the synonym context, 25.60% of students confused the term with "state".

Terms problematic in two contexts. Furthermore, 12 out of 30 terms were problematic in two contexts (see Table 10). Results showed that students' performance on the term "classify" was weakest in the science context where the majority (67.40%) interpreted the term as "identify" instead of categorize. Also, in the synonym context, participants confused it with a look alike or sound alike word "clarify". In fact, when asked to define the term, one participant who was interviewed said: "it is when you explain something".

Analysis of the responses on the distractors as well as semi-structured interviews revealed that participants tend to assign imprecise meanings to the term "diagnose". For instance, 51.30% of participants' defined the term as "infer" in the synonym context while 32.60% confused it with "measure" in the everyday context. Furthermore, there appears to be confusion between "diagnose" and "treat" as seen by student responses in the semi-structured interviews. One participant who was interviewed defined it as "making someone better" while another gave the following sentence: "The doctor gave the man medicine and diagnosed him".

Participants also had difficulties understanding the term "estimate" in the synonym context as well as the everyday context. In both contexts respectively, 54.30% and 48.70% of the participants confused the term with "calculate" or "accurate measurement". During the interviews, when asked to explain the meaning of the term, one participant defined it as "using a calculator". Furthermore, in the everyday context, 30% of participants confused the term "converge" with "converse" which is a word that looks and sounds the same. When asked about the difference between "converge" and "converse", three out of five participants who were interviewed chose not to answer. In the synonym context, 35.90% of participants chose to define it as "change".

Another term which was problematic in two contexts was "impact". Participants lacked precision in defining the term in the synonym context. Instead of referring to the action itself, 34.90% of participants defined it as "damage". Also in the non-science context, 21.70% of participants confused the term with "product". Moreover, most participants (61.50%) lacked precision in defining the term "sequence" in the synonym context where it was defined as "what follows after" instead of "unbroken series". During the interviews, one participant further confirmed this finding by saying "the sequence of Grade 6 is Grade 7". Furthermore, when the term was placed in a science context, 26.10% of participants confused "sequence" with "quality".

Similar to the results obtained by Cassels and Johnstone (1985), three common sources of difficulty related to non-technical terms were identified. In the everyday context, participants often confuse the term with words that look or sound the same. The common factor between non-technical terms and other words that looked or sounded the same was that both groups had a similar sequence of letters. They also often allocated imprecise meaning to the terms, especially when found in the science context. Others tended to appoint opposite meaning to non-technical terms. A word by words analysis is included in appendix V which details participants' common sources of difficulty for each problematic term across each context.

Fourth Research Question: Variations in the Comprehension of Non-technical Terms with Age

The third research question explores whether comprehension of problematic non-technical terms improves with age. Based on the procedure followed by Marshall and Gilmour (1990), analysis aimed to identify first the overall performance at each grade level, second whether each term improved with age and finally to determine if performance in each context improved with age.

Overall performance in each grade level. The total percentage of correct responses in each grade (see Table 11) revealed that participants in Grade 9 performed better (48.40 % correct responses) than participants in other grades. Participants in Grade 6 achieved the lowest percentage of correct responses overall (40.30%).

A one-way ANOVA was conducted to the study the relationship between grade level and percentage of correct responses. Before conducting the main analysis, the assumptions of normality and homogeneity of variances were checked. Since the sample size was less than 50 in all the groups, as such the Shapiro-Wilk test was used to check for normality. The Shapiro-Wilk test revealed that the distribution of percentage of correct responses was normally distributed across Grade 6, Grade 7, Grade 8 and Grade 9; $W (31) = 0.97$, $p = .50$, ns, $W (45) = 0.98$, $p = .65$, ns, $W (42) = 0.96$, $p = .11$, ns, $W (49) = 0.96$, $p = .07$, ns, respectively. Regarding the homogeneity of variance, the Levene's test revealed that the variances of the percentage of correct responses were significantly different across the four groups; $F (3, 163) = 3.14$, $p = .027$. Hence, homogeneity of variance assumption is not met. Since the homogeneity of variance assumption was not met and the sample size is not the same across the four groups, hence the F-Welch test was reported. The F-Welch revealed that there is no significant relationship between grade level and percentage of correct responses; F-Welch $(3, 89.06) = 1.10$, $p = .35$, ns. As such, results showed that while there was a tendency for percentage of correct responses to increase with grade level, this increase was not significant.

Table 11

Percentage of correct responses in each grade

	Grade 6	Grade 7	Grade 8	Grade 9
Percentage of correct responses	40.30	41.60	41.70	48.40

Difference in performance of each term from grade to grade. The percentages of correct responses for each of the 30 problematic terms in each grade were first obtained (see Table 12). Results revealed an increase for 22 out of the 30 words from Grade 6 to Grade 9 (equivalent to 73% of the words). The term "agent" had the largest effect across grades with an increase of 37.5% from Grade 6 (25.80%) to Grade 9 (63.30%). Similarly for the term "initial," where there was a difference of 34.30 % in percentage between Grade 6 (29 %) to Grade 9 (63.3 %). As for the word "devise", a total increase of 30.8% was evident between Grade 6 (16.10%) and Grade 9 (46.90%). Likewise, for the term "emit" correct responses increased from 29% in Grade 6 to 57.10 % in Grade 9 revealing a difference of 28.1%. Other terms which showed an increase across grades include “probability” (an increase of 21.1), “valid” (an increase of 24.3%) and “influence” (an increase of 20.1%). As for the remaining terms, they showed slight improvement ranging between an increase of one to five percent (see Table 10).

The remaining eight terms, which constitute around 27% of the problematic terms, showed a decrease from sixth to the ninth grade (see Table 10). Specifically the largest decrease was evident for the term "relative" which decreased from 51.6 % in Grade 6 to 36.7% in Grade 9 indicating (a decrease of 14.9%) Another decrease in scores was observed for the term “rate”, which decreased from 48.40% in the sixth grade to 36.70% in the ninth grade, an 11.7% decrease in scores. Other terms which showed a slight decrease from Grade 6 to Grade 9 include “efficient” (by 6.7 %), “system” (by 4.7%) “estimate” (by 4.4%), “reference” (by 4%), “linear” (by 0.6%), and factor (by 1.1%).

Table 12
Percentage of correct responses within each grade per term

Non-technical Term	Grade 6	Grade 7	Grade 8	Grade 9
Classify	45.20	42.20	40.50	61.20
Device	54.80	40.00	45.20	59.20
Diagnose	41.90	48.90	42.90	42.90
Emit	29.00	33.30	47.60	57.10
Estimate	45.20	48.90	52.40	40.80
Exert	48.40	51.10	33.30	51.00
Agent	25.80	51.10	50.00	63.30
Converge	35.50	24.40	47.60	49.00
Devise	16.10	35.60	31.00	46.90
Disperse	35.50	42.20	40.50	40.80
Efficient	51.60	37.80	50.00	44.90
Excess	48.40	46.70	40.50	59.20
Factors	41.90	46.70	35.70	40.80
Impact	45.20	44.40	40.50	51.00
Influence	45.20	40.00	40.50	65.30
Initial	29.00	53.30	33.30	63.30
Linear	51.60	46.70	40.50	51.00
Probability	25.80	22.20	33.30	46.90
Rate	48.40	46.70	47.60	36.70
Reference	38.70	37.80	38.10	34.70
Relative	51.60	46.70	35.70	36.70
Relevant	41.90	40.00	47.60	42.90
Sequence	48.40	51.10	38.10	51.00
Source	41.90	48.90	45.20	49.00
Standard	32.30	42.20	40.50	40.80
Stimulate	41.90	24.40	42.90	46.90
Symmetrical	45.20	31.10	42.90	49.00
System	51.60	44.40	50.00	46.90
Theory	29.00	37.80	42.90	36.70
Valid	22.60	40.00	33.30	46.90

Difference in performance in each context from grade to grade. The purpose of this analysis is to determine whether overall performance in each context changed with grade levels. The percentage of correct responses in each context was identified and compared across grades (see Table 13). It is apparent that within the synonym context, participants in Grade 6 had the poorest performance (33.84% correct responses). Surprisingly, Grade 7 students achieved a larger percentage of correct responses (42.67%) on the synonym context in comparison to Grade 8 (39.68%) and almost equal performance to Grade 9 students (42.11%). In the case of the everyday context, Grade 9 students outperformed the remaining grades (48.73%) while Grade 8 students demonstrated the poorest performance (37.22%). As for the science context, both Grades 6 and 7 students achieved the lowest percentage of correct responses (41.11%). Grade 9 students outperformed all grades with 52.10% correct response on the science context. Similarly, in the case of the non-science context, Grade 9 students outperformed all grades (52.64% correct response) while Grade 7 students demonstrated the poorest performance (42.44% correct response). In general, it is apparent that in the case of the science and non-science contexts, there was a tendency for the percentages of correct responses to increase with age. However, this was not the case for the synonym and everyday contexts where increase in the percentage of correct response was not sustained across grade levels.

Table 13
Percentage of Correct Responses in Each Context Within each Grade

Context	Grade 6	Grade 7	Grade 8	Grade 9
Synonym	33.84	42.67	39.68	42.11
Everyday	40.93	39.89	37.22	48.73
Science	41.11	41.11	44.64	52.10
Non science	46.11	42.44	45.07	52.64

Changes in understanding of individual terms in contexts with grade. An additional analysis was conducted to identify whether there were changes in the understanding of terms in contexts with grade. More specifically, the aim was to recognize if any patterns exist for these changes with age. For each non-technical term, the percentage of correct responses was first calculated for each context in each grade (see Appendix VI). Then, for each grade level, non-technical terms were grouped based on participants' performance in each context. As such terms were grouped into three categories; terms problematic across four contexts, terms problematic across three contexts and terms problematic across two contexts. Table 14 compares three categories of problematic terms across each grade level.

The first category of non-technical terms includes those which were most problematic since they were challenging in all of the contexts. It is evident that these terms are inconsistent across grade levels and tend to change with grade. For instance, only participants in Grade 6 found the term "agent" problematic across the four contexts while the term "factor" was only problematic for Grade 8 participants. The number of terms also gradually decreases with age in such a way that, by the time participants reach Grade 9, none of the non-technical terms are challenging in all four contexts.

The second category of terms includes those which were slightly less challenging since they were difficult in three out of four contexts. Contrary to the observation made with the first category, some terms continued to be problematic with each grade level. For instance, participants' performance on the term "disperse" was weak across three contexts from Grade 6 through Grade 9 while the term "stimulate" was challenging in three contexts from grades six to Grade 8. Surprisingly, participants in grades eight and nine found the term "theory" challenging in three contexts while Grade 7 students only found it challenging in two out of four contexts. Furthermore, the comprehension of some terms was inconsistent across grade levels. For instance, the terms "initial" and "symmetrical" were problematic only in grades six and eight while "valid" was problematic in seven and eight. Another surprising observation is that the number of challenging terms in three contexts increases in Grade 8 then drastically decreases in Grade 9.

For the final category, which includes terms problematic in two out of four contexts, the same inconsistent pattern was evident. Terms such as "factor" and "impact" were only challenging in grades six and seven while others such as "relevant" and "exert" were problematic in grades six, seven and nine. Similar to the observations made in the previous category, only participants in grades eight and nine found some terms such as "efficient" and "system" challenging in two contexts. Surprisingly, the number of challenging terms in Grade 9 in that category was much greater than lower grades. The only term which was consistently problematic across all grade levels was "diagnose". A vertical analysis of the results shows that some terms were more challenging in upper grades than lower. For instance, while the term "impact" was least problematic in grades six and seven (categorized as challenging in 2/4 context), Grade 8 participants found it challenging in all four contexts. These observations were also made for other terms such as "excess", "exert", "rate" and "theory".

In general, results showed that there was a tendency for percentages of correct responses to increase with grade. However, a deeper analysis showed that understanding of individual terms was inconsistent across grade levels. For instance, for some terms, percentage of correct responses increased with grade while for others the opposite was observed. In other cases an absence of clear pattern was evident was evident.

Table 14

Number of Non-Technical Terms Problematic in 4/4, 3/4 and 2/4 Contexts Across Grade Levels

	Grade 6	Grade 7	Grade 8	Grade 9
Terms problematic in 4 out of 4 contexts	Agent Devise Theory Valid	Converge Efficient Probability Symmetrical	Devise Factors Impact	
Total Number	4	4	3	0
Terms problematic in 3 out of 4 contexts	Converge Disperse Emit Initial Probability Source Standard Stimulate Symmetrical	Device Devise Disperse Emit Excess Influence Reference Stimulate Valid	Disperse Excess Exert Initial Linear Probability Rate Reference Relative Stimulate Symmetrical Theory Valid	Disperse Factors Reference Relative Standard Theory
Total Number	9	9	13	6
Terms problematic in 2 out of 4 contexts	Diagnose Excess Exert Factor Influence Impact Reference Relevant	Classify Diagnose Estimate Exert Factor Impact Initial Linear Rate Relevant Sequence Source Standard Theory	Classify Converge Device Diagnose Emit Efficient Estimate Influence Sequence Standard System	Classify Converge Devise Diagnose Estimate Efficient Exert Probability Rate Relevant Sequence Source Stimulate Symmetrical System Valid
Total Number	8	14	11	16

Fifth Research Question: Correlation between Comprehension of Non-technical Terms and PSAT Scores

Out of 91 participants in Grades 8 and 9, 71 students agreed to provide their PSAT scores. Before conducting the main analysis, the assumption of normality across the PSAT and the percentage of corrected responses was checked. Since the sample size was less than 100, as such the Shapiro-Wilk test was used to check for normality (Field, 2013). The Shapiro-Wilk test revealed that the distributions of PSAT and percentage of correct responses were not normally distributed; $W(70) = 0.96$, $p = .043$, $W(70) = 0.96$, $p = .044$, respectively. Since the normality was not met, as such a Spearman Rho's correlation test was conducted to study the relationship between PSAT and percentage of correct responses. The results revealed that there was a significant positive and medium to large correlation between PSAT scores and percentage of correct responses, $r_s = .47$, $p < .001$. This indicates that participants who had higher levels of PSAT scores tended to have higher levels of percentage of correct responses indicating better understanding of non-technical terms.

As a supplementary analysis, a simple linear regression analysis was conducted to test the relation between the predictor PSAT and the outcome variable Percentage of Correct Responses. The aim was to establish whether PSAT scores can predict student's total scores on the questionnaire for comprehension of non-technical words. The regression established that PSAT scores were significant predictors of questionnaire score; $F(1, 69) = 24.51$, $p < .001$, and PSAT scores accounted for 25.1% of the explained variability in comprehension of non-technical words in the science context. Results showed that an increase in one point on PSAT scores leads to a 0.15 increase in scores (over 100) on the questionnaire. Predictions were made to determine mean total scores on the questionnaire (over 100) for people who achieved a PSAT score of 130, 500 and 700. If individuals achieved a score of 130 on their PSAT, they would have a predicted overall score of 8.00/100 on the questionnaire. If they achieved a score of 500 on the PSAT, their predicted score on the questionnaire would be they 63/100. With a score of 700, their predicted score on the questionnaire would be 93/100. The scatterplot summarizes the results (Figure 2)

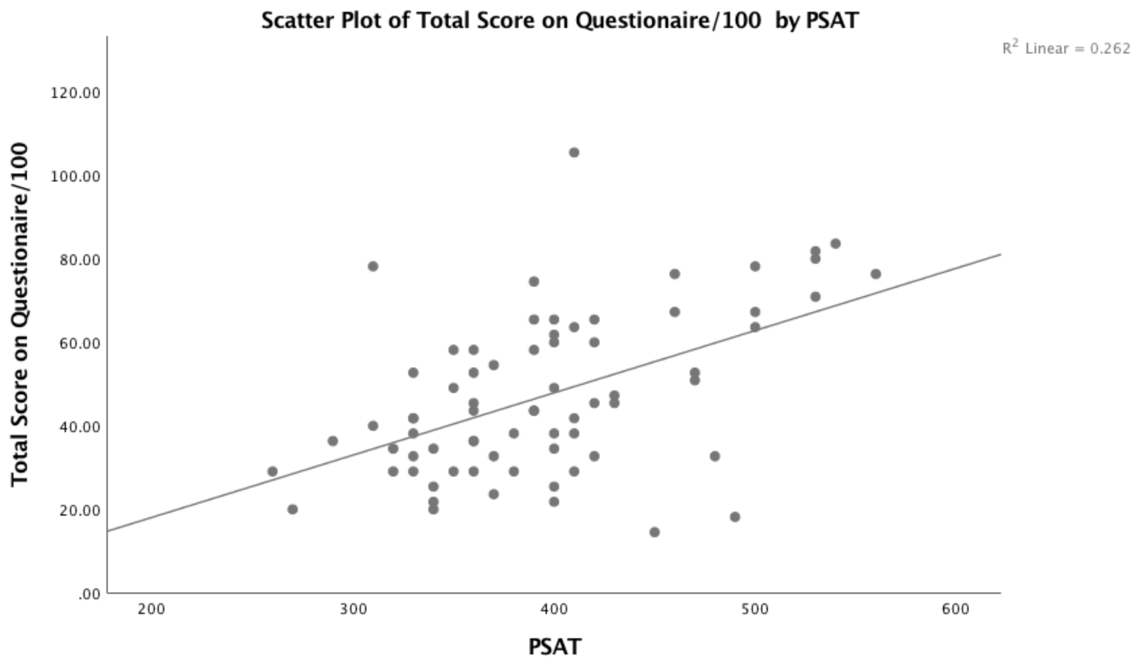

Figure 2. A simple scatterplot establishing the linear relationship between PSAT scores and total scores on the questionnaire (over 100).

CHAPTER V

DISCUSSION

The aim of this study was to investigate Lebanese middle school ELLs' comprehension of non-technical terms encountered in American science textbooks. This chapter consists of four sections. The first section presents a summary and a discussion of the research findings organized by research question. The second section presents the limitations of the study while the third and fourth sections discuss recommendations for both research and practice, respectively.

Discussion of Results

The study examined the comprehension of 50 non-technical terms, which were frequently encountered in American science textbooks used in a Lebanese school. Following the Cassels and Johnstone (1985) study, four test versions (Pink, Green, Blue and Yellow) were prepared to examine the comprehension of the 50 selected terms. Each test included each term in one of the following four contexts: one word synonym without a context, four everyday situations with only one that is correct, a science context or a non-science context. The one word synonym without a context format requires that the student identify the dictionary like meaning of a term. In the case of the science context, each term is embedded in a science-related stem and participants must choose the intended meaning from the options provided. Although both the everyday and non-science contexts are related to real life events, the purpose of each context differs. More specifically, the everyday context aims to identify whether students confuse non-technical terms with other words that look or sound the same while the non-science context aims to establish whether students better understand terms in daily events more than in science contexts (Cassels & Johnstone, 1985).

First research question: the extent of ELL's comprehension of non-technical terms. Results clearly show that ELLs in this study do not fully understand many non-technical terms in their science texts. In fact, out of 50 terms investigated, overall performance was satisfactory (performance showing more than 50% correct response across the whole sample) for only 20 terms. For the remaining 30 terms, which constitute the majority of the non-technical terms (60%), analysis of students' overall performance revealed that less than 50% of responses were correct. This finding indicates that, much like ELLs in other contexts, ELLs in Lebanon face difficulties in understanding non-technical terms in science texts. In fact, the severity of the problem in the school under study is similar to other contexts. Specifically, Marshall and Gilmour (1990) reported that for middle school ELLs in Papua New Guinea, 71% of non-technical terms investigated were problematic and required special attention. Similar results were also obtained by Farrell and Ventura (1998), who conducted a study on Maltese secondary school students' comprehension of 50 non-technical terms in physics. The general expectation was that each term would be understood by at least 80% of participants. However, results showed that for the majority of non-technical terms (62%), the expected threshold was not met.

The only other study which investigated the understanding of non-technical terms in Lebanon was conducted by Radwan (2013) on Lebanese elementary school ELLs. The study specifically focused on sixth-grade ELLs' understanding of 39 terms identified from Cassel and Johnstone's (1985) list of 95 problematic non-technical terms. Similar to the current study, the author reported that the majority (71.1%) of non-technical terms were difficult to comprehend in various contexts. In both studies, students performed poorly on frequently encountered terms which they were expected to know and be competent in explaining.

Second research question: ELLs' comprehension of problematic non-technical terms across contexts. Upon identifying the 30 problematic terms, the study then focused on analyzing students' understanding of these terms instead of the 50 initial non-technical terms. One reason is that analysis of the results revealed that for 20 out of the 50 terms, students' performance was strong (more than 50% correct response) in all four contexts and across the sample. Furthermore, a series of analysis were conducted in order to identify problematic contexts (second research question) as well as sources of difficulty (third research question) which required the researcher to focus on a particular subset of the words assessed (problematic words).

In order to examine the effect of context on the comprehension of the 30 problematic non-technical terms, the sample's overall performance in each context was identified. In general, results revealed poor performances (less than 50% correct response) across the four contexts. Students' responses were almost equally weak for the one word synonym without a context (40.19 % correct response) and the everyday contexts (41.89% correct response). The percentages of correct responses were slightly higher for the science (45.20% correct response) and non-science contexts (46.90% correct response). In line with the findings reported, numerous other studies also found that students' performance was weakest in a one-word synonym without a context format (Cassels & Johnstone, 1985; Childs & O'Farrell, 2003; Marshall & Gilmour, 1990; Marshall, Gilmour & Lewis, 1991; Pickersgill & Lock, 1991). One possible reason for this finding is that participants have either acquired the concept but lack the sufficient explicit lexical knowledge to identify the correct synonym or that more attention is needed to explain the meanings of the terms and clarify the concept (Marshall & Gilmour , 1990; Marshall et al., 1991). Another possible explanation for this finding is that terms placed in the everyday, science and non-science contexts include sufficient contextual clues that might help students in identifying the meaning of terms. In the absence of context (such as the case of the synonym format), ELLs might find it more difficult to identify the precise meaning of terms compared to native language speakers (Child & O'Farrell, 2003; Pickersgill & Lock, 1991). As such, any context, even an unfamiliar one such as the science one, would assist students in identifying the meaning of terms (Child & O'Farrell, 2003). This explanation relates to theories of social constructivists which emphasize that meaning is constructed through social practices (Rollnick, 2000). Vygotsky (1978) identified learning as a type of enculturation which occurs through the adoption of social practices. In other words, according to Rollnick (2000), the comprehension of a word is derived from the function of the word in the context in which it is used.

It is worth mentioning that ELLs are at a greater disadvantage in identifying contextual clues relative to native language speakers. Searching for contextual clues requires that the reader uses words that are familiar as scaffolds in order to identify the meaning of those which are less familiar. For ELLs, this task is difficult since the number of unfamiliar words (whether technical or non-technical) is far greater compared to native language speakers. As such, ELLs have fewer resources for identifying meaning from texts and so require more assistance than others.

Poor performance in the everyday context indicates that ELLs not only have difficulty in understanding the meaning of the term (as revealed by the difficulty in identifying correct synonyms) but also have trouble in using them correctly. In Hong Kong, Tao's (1994) study on students' comprehension of non-technical terms in science revealed similar results. The author maintained that correct usage of a term is more demanding than its comprehension. The investigation was conducted in a context where, like Lebanon, textbooks were written in a second language and frequent code switching occurred between the native and English language. In such a case, students related English terms to their meaning in their native language but were unable to properly use them in sentences (Tao, 1994).

Interestingly, students demonstrated a better understanding of non-technical terms placed in a science context than in a synonym or everyday contexts. This further indicates that in the presence of a context, the meaning of a term is more easily extracted. In fact, performance on 11 out of 30 problematic terms was strongest in the science context (see Table 5). This was the case for terms such as "exert", "stimulate", "source" and "estimate". Similar results were reported by Marshall and Gilmour (1990) who found that ELLs' performance was strongest in the science context for over 30% of non -technical terms. They explain that students first learn the meanings of these terms in science class and as such it is expected that their performance would be strongest in the science context. A similar situation exists in the case of participants in this study. For instance, students in Grades 6 and 7 first get introduced to terms such as "exert," "converge," and "impact" in the chapters related to motion and energy. Such non-technical terms, which are central to the understanding of scientific concepts, are often purposefully explained in class.

ELLs especially, when compared to native language speakers, are more likely to encounter non-technical terms first in a science context. Given that native language learners are exposed to the English language in informal settings at a much earlier stage, they are therefore at an advantage of learning the various uses and meanings of terms (Johnstone & Selepeng, 2001). This was evident in the study conducted by Childs and O'Farrell (2003) that compared the performance of ELLs and native language speakers in each of the four contexts. It was evident that ELLs' performance was far weaker in the science context compared to native language speakers. The authors explain that this finding is not surprising since ELLs have limited exposure to the variety of ways in which a term may be used and as such may not be aware of its meaning when used in a science context.

Out of the four contexts investigated, participants' comprehension was strongest in the non-science context (46.70 % correct response). This finding indicates that ELLs in the study are more familiar with the everyday meanings of non-technical terms more than their scientific one. A comparison of students' responses in the non-science and science contexts reveals that for the majority of terms (53%) correct responses were higher in the former context (see Table 5). This was the case for terms such as "classify", "diagnose" and "rate". Similar results were obtained by numerous other studies (Cassels and Johnstone, 1980; Childs & O'Farrell, 2003; Radwan, 2013; Tao, 1994).

This finding reflects Cummins' (2000) work who distinguished between two varieties of language use: basic interpersonal communicative skills (BICS) and cognitive academic language proficiency (CALP). On the one hand, BICS reflects a language proficiency which is used in informal everyday conversations and is embedded in context. Comprehension, in this case, is facilitated by the presence of cues such as non-verbal gestures and shared discourse. On the other hand, CALP is needed for cognitive and academic tasks such as reading, participating in debates and writing responses. Contrary to BICS, CALP lacks extra linguistic contextual support and so students are obliged to rely solely on their understanding of the language used. In fact, according to Cummins (2000), ELLs experience a delay of five to seven years in acquiring CALP and so any early fluency in English is attributed to fluency in BICS. It is worth mentioning that this distinction was made in contexts were English is the dominant spoken societal language.

As such, some differences arise in the discussion of BICS in Arabic speaking countries such as Lebanon. ELLs in North American have more opportunities to develop BICS in English since they are obliged to use it in informal settings outside their home. In contrast, ELLs in Arabic speaking countries are limited in their development of BICS in English since the language of choice for informal situations is mainly Arabic (Ali & Ismail, 2006; Amin, 2009). Given the limited exposure of English in informal settings, it would be expected that ELLs in Arabic speaking countries have less opportunities to get acquainted with the everyday meaning of non-technical terms. The findings reported by Childs and O'Farrell (2003) corroborate this interpretation. The authors maintain that a strong comprehension of non-technical terms in an everyday context is evident for both native and non-native English language speakers with the latter having the weaker performance.

Despite these differences, the CALP and BICS distinction could be appropriate in the context of this study in particular since participants belong to middle to high socio economic status. Contrary to ELLs belonging to lower SES, these students have a high exposure to conversational English between friends and family members and therefore have more opportunities to develop their BICS in English. In fact, based on the language profiles, 60% of participants in this study prefer to use only English or a mix of English and Arabic with family and friends. In relation to the study, questions in the non-science context mirrored those which use BICS and included situations commonly encountered by students in their daily lives. This explains why ELLs' performance was better when terms were included in a non-science context. Yet, in the case of a science context, the items in the questionnaire incorporated non-technical terms used in the specialized language of science which related to the use of CALP. As such, based on this theory, one reason for the poor performance in the science context is that ELLs are still in the process of developing their CALP skills and therefore struggle more in understanding non-technical terms in science context.

The only study conducted in Lebanon was that of Radwan (2013) and as such it is significant to compare its findings with those reported in this study. However it is worth mentioning two important distinctions between the two studies. First, Radwan's (2013) study focused on only Grade 6 Lebanese ELLs while the current study included all middle school students of various nationalities. Second, contrary to the current study, the analysis of students' performance across contexts focused not only on problematic terms instead the performance was analyzed for all the terms identified from the chosen science textbook. Despite these differences, it is interesting to compare any differences in results obtained.

Similar to this study, Radwan (2013) found that the presence of a context facilitated the comprehension of terms and that ELLs were mostly familiar with the everyday meaning of terms. However, a major difference was that students in Radwan's (2013) sample performed better in the synonym context than the students in the current study. Terms placed in synonym questions are not embedded within a context and so students are required to rely solely on their English language skills in identifying an appropriate synonym. Contrary to the Radwan (2013) sample which included only Lebanese grade 6 ELLs, the sample in the school under study includes students of diverse backgrounds and nationalities, some with particularly weaker English language skills. It is therefore expected that they have varying degrees of English language proficiency which may affect their ability in correctly answering synonym questions.

Third research question: sources of difficulty related to non-technical terms. In order to answer the third research question, participants' performance on each distractor was analyzed.

Results revealed three major sources of difficulty in understanding non-technical terms: confusion with words that are close in meaning, confusion with look-alike or sound-alike terms and or confusion with words having opposite meaning. These sources of difficulty were also reported by numerous other studies which investigated students' comprehension of non-technical terms (Cassels & Johnstone, 1985; Johnstone & Selepeng, 2001; Marshall & Gilmour, 1990; Marshall et al., 1991; O'Rafferty, 1989; Pickersgill & Lock, 1991). In the context of Lebanon, similar findings were reported for Grade 6 ELLs in Lebanon (Radwan, 2013). Sources of difficulty also included confusion with look-alike and sound-alike terms as well as assigning words with opposite meanings.

First, participants often assigned imprecise meanings to non-technical terms especially when found in the science context. This resulted in confusion of terms with others that are closely related or somewhat overlapping in meaning. For instance, "probability" was confused with "possibility", "theory" with "facts" and "diagnose" with "treat". Students assume that the meanings of non-technical terms in their everyday sense are identical to their science one and so they tend to assign meanings imprecisely. This source of difficulty is problematic since in the case of an everyday context, assigning a closely related meaning can be acceptable, however, in a science context a precise meaning is required (Cassels & Johnstone, 1985).

When in doubt, participants also often confused non-technical terms with words that look or sound the same. .For instance, "converge" was confused with "converse", "influence" with "instance", "agent" with "accent", "source" with "sauce" and "efficient" with "sufficient". One possible explanation for this finding is that, due to their limited English language proficiency, ELLs tend to employ strategies in recognizing meaning of unfamiliar words. For instance, Higgins (1966) explains that Japanese students look for alternative words that have similar sequence of letters while speakers of European languages identify words with similar stems. Such confusion may also arise because students are not sufficiently familiar with the word, its meaning or the way it is used (Pickersgill & Lock, 1991). This is not surprising especially in the case of ELLs who have had limited exposure to the ways in which a word is used.

Furthermore, participants assigned words with opposite meanings. For instance, "stimulate" was confused with "deactivate", "estimate" with "calculate" and "emit" with "absorb". Students chose antonyms for non-technical terms both on the questionnaire and during the semi-structured interviews indicating that this source of difficulty is somewhat common for the ELLs in this study. Two major conclusions can be derived from this finding. First, ELLs in this study have a poor understanding of the meaning of these non-technical terms (Tao, 1994). Second, this confusion is worrisome since it may result in the solidification of misconceptions (Cassels & Johnstone, 1985; Pickersgill & Lock, 1991). Since these terms are commonly encountered in everyday discourse, it is not surprising to find that the associated misconceptions have been reinforced over the years and are deeply rooted in students' minds. As such, attempts to correct these misunderstandings might be perceived as an attack on students' core beliefs and would be strongly resisted (Pickersgill & Lock, 1991). This was evident in the case of participants' confusion of the term "estimate" with "calculate" where despite students' exposure to the terms in both science and math classes, students continued to confuse the two terms indicating that misconceptions exist.

Fourth research question: variations in the comprehension of non-technical terms with grade. The fourth research question addressed whether participants' comprehension of non-technical terms improved with grade. In general, results revealed that while there was a tendency for percentage of correct responses to increase with grade, this improvement was not significant. This result is consistent with the findings reported by other studies (Cassels & Johnstone, 1985 ; Marshall & Gilmour, 1990; Marshall et al, 1991).

More specifically, data was further analyzed to identify differences in performance of each problematic term from grade to grade. Results revealed that for the majority of terms (73%), term comprehension improved with grade. Further analysis revealed that improvement between Grade 6 and Grade 9 on some terms (such as "agent" and "initial") was substantial, while others was moderate (such as "valid" and "influence"). Surprisingly, for a few problematic terms (2%), results showed a decline in the comprehension of terms between Grade 6 and Grade 9 (such as "relative" and "rate"). Furthermore, analysis of differences in overall performance in each context across grade levels was performed. Results indicated a tendency for percentages of correct responses to increase in the science context with grade (see Table 13). While in the case of the synonym, everyday context and non-science contexts, this increase was not sustained across grade levels. Similar results were reported by other studies (Marshall & Gilmour, 1990; Marshall et al, 1991).

This general level of analysis was not sufficient to get an accurate picture of the kinds of changes taking place and what was driving them. As such, for each grade level, the percentages of correct responses for each problematic term in each context were compared. A number of major findings were identified. First, some terms were consistently problematic for all grade levels (such as the case of "disperse" which was problematic for all grades in three out of four contexts). The fact that terms problematic for Grade 6 students are still problematic for Grade 9 students suggests that there is a need for vocabulary improvement accompanied by regular reinforcement (Childs & O' Farrell, 2003).

Surprisingly, for numerous problematic terms improvement was not sustained across grade levels. For instance, the term "devise" was problematic for Grade 8 students in all four contexts while Grade 7 students found it difficult in three out of four contexts. Similarly, Grade 9 students found the term "factors" difficult in three out of four contexts while Grades 6 and Grade 7 found it difficult in two out of four contexts. Also, results showed that the term "theory" was problematic for Grade 7 students in two out four contexts while in Grade 9 it was problematic in three out of four contexts. Furthermore, the terms "factors" and "impact" were problematic for Grade 8 students in all four contexts while Grade 6 and Grade 7 students found them difficult in only two out of four contexts.

One possible explanation for this pattern (or absence of a pattern of steady improvement) is that level of comprehension of the term is related to the curriculum taught at that specific grade level. For instance, Grade 7 students are explicitly taught the term "initial" during the unit on speed and motion and as such have less difficulty understanding it when found in numerous contexts. In the following grades, since the term is not addressed in the curriculum, students might have trouble recalling the meaning of the term and face difficulty understanding it in some contexts. These findings suggest that the comprehension of non-technical terms might be curriculum dependent. In other words, in one particular grade, certain terms might be highlighted as part of a required unit and therefore more easily comprehended in numerous contexts. However, in the remaining grades, when these terms are no longer emphasized in class, students most likely face difficulties understanding them in various contexts. In fact, given the results reported, it seems that the more important factor with student performance on terms is whether it was recently covered in the curriculum,

Fifth research question: correlation between comprehension of non-technical terms and PSAT score. One of the major findings reported by Cassels and Johnstone (1980) was that students' understanding of non-technical terms is related to their verbal reasoning skills. This study also investigated whether a relationship exists between participants' comprehension of non-technical terms and their PSAT critical reading scores. Results have confirmed that quantitative measures of language comprehension using PSAT critical reading scores are significantly correlated with ELLs' comprehension of non-technical terms. Similar results were obtained by Pickergill and Lock (1991) in Britain who found a positive correlation between students' score on a verbal reasoning test and on a test of understanding of non-technical terms. One possible reason for this strong relationship relates to the purpose and the design of the critical reading section of the PSAT. According to the College Board, the reading test includes passages in the fields of science, history and social studies. This section measures the student's ability to identify the meanings of words found in these texts through the use of contextual clues and other verbal reasoning skills. On one hand, it is reasonable to expect that students who are familiar with non-technical terms and their different meanings in various contexts would be able to identify the meaning of similar terms found in the PSAT passages. On the other hand, students who have adequate verbal reasoning skills (as demonstrated by their performance in the PSAT) would also be able to use these skills to identify the meanings of nontechnical terms.

While no other study has investigated the relationship between these two variables, numerous others have reported a positive correlation between SAT scores and students' general achievement scores in scientific disciplines. For instance, a study conducted by Pyburn et al. (2013) explored whether university students' language comprehension ability correlated with their performance in general chemistry courses. Students' chemistry performance and their language comprehension abilities were measured using an assessment developed by the American Chemical Society and the SAT critical reading section scores, respectively. Results revealed a significant correlation between language comprehension and course performance. Similarly, another study conducted by Lewis and Lewis (2007) found a strong positive relationship between university students' general achievement (as measured by their SAT scores) and their academic performance in chemistry courses. In the context of Lebanon, and contrary to the findings in this study, Dandashly (2005) reported a non-significant correlation between university students' SAT verbal scores and their biology course scores. She explained that one possible explanation for her results is the small number of participants taking the test.

There are three major implications for this finding. In general, this finding further confirms Cassels and Johnstone's (1980) result and expands it to include ELLs. In other words, the association between non-technical term understanding and verbal reasoning scores is not only limited to native English language speakers but also extends to ELLs. Furthermore, a positive correlation between PSAT scores and non-technical term understanding suggests that the purpose of these tests extends beyond being just a predictive measure of students' academic success in university. In fact, verbal reasoning scores on standardized tests can be used to assess students' reading comprehension abilities beyond the English class to include science. More specifically, scores are shown to be predicative of students' comprehension of non-technical terms in science. Given this correlation, standardized tests can be used by science teachers to identify students that need assistance in understanding non-technical terms.

Limitations of the Study

There were some limitations to this study. An important limitation, which might have affected the results of the study is when the sessions for responding to the questionnaires were scheduled. Due to difficulties in booking a common space for all participants, each grade level completed the questionnaire during different times of the day and in different classes. Factors such as students' degree of concentration as well as environmental factors such as noise level and various other distractions might have affected their performance on the questionnaire. Furthermore, the five students who were interviewed were reluctant to provide responses to many of the questions asked. One possible reason is that students in this school are not accustomed to participating in research studies. As such, despite reassurance, many students were afraid to give incorrect responses and preferred to skip answering numerous questions.

Furthermore, the study was conducted in only one Lebanese school in Beirut and as such the generalizability of results is limited. The school under study caters for students who belong to middle and high socio economic status groups. Compared to students belonging to lower SES, participants in this study have more exposure to the English language in informal settings and therefore have more opportunities to develop their BICS in English. As discussed earlier, development of BICS in English allows more opportunities to learn the meaning of non-technical terms in everyday situations. Given these differences, the results in this study cannot be generalized to all ELLs of all SES in Lebanon.

Also, the school under study has a special system for grouping students based on their academic level. In this homogeneous system of grouping, students are assigned to either a basic, standard or high level class in each subject matter. These allocations are decided based on each student's competence in each subject matter. For instance, one student may be assigned to the standard class in science and the high class in English. Regardless of the levels assigned, the curriculum remains the same with the only difference being the complexity of material discussed in class. So for instance, all grade 6 students regardless of their levels (basic, standard and high) are required to study ecology in the first trimester. The difference is that students belonging to the basic grade 6 science class are exposed to simplified ecology content while those belonging to the standard and high classes are required to engage in more critical thinking and analysis of ecology topics. Similarly, students in the high English classes are exposed to more complex reading material than those in the standard and basic classes. Contrary to other schools in Lebanon where students of the same grade level experience the same complexity of content in each subject matter, the difficulty of the content varies according to whether the student is assigned a basic, standard or high class. So, to generalize that all Grade 6 students in the school under study have a similar exposure to non-technical terms is not completely accurate. Furthermore, given this unique system of grouping students into homogeneous groups, the results may not apply to other schools where this system is absent.

Implications for Practice

It is evident that ELLs in Lebanon face difficulties in understanding non-technical terms in science. Given the findings reported, there are numerous implications for practice. In general, the fact that the majority of non-technical terms investigated were problematic indicates that most of these terms are not accessible to ELLs in the school under study. This finding suggests that science teachers in the school need to be first and foremost aware of their students' struggle in understanding these terms. The literature identifies numerous strategies that may help facilitate non-technical term comprehension for ELLs. For instance, Cassels and Johnstone (1985) investigated the effect of language modifications on students' performance on multiple choice tests in chemistry. The authors investigated the effect of substituting terms with simpler ones. So for instance "stable" were replaced with "break down to its elements". Results revealed that students' performance on the simplified questions was better (as indicated by higher percentage of correct responses) than on the original questions. Other modifications which resulted in similar improvements included replacing negative expressions with positive ones, removing unnecessary information and rewording texts to include simple sentences instead of long and complex ones. Similarly, Bird and Welford (1995) investigated whether modification to test questions used GCSE and Cambridge GCE examinations would improve ELLs' performances. The types of modifications included changes in length through the removal of extraneous information, replacement of difficult terms with more familiar ones and changes in syntax through the rearrangement of grammatical structures. Results revealed a significant improvement in ELLs' performances. Given these findings, it would be interesting to examine whether such modifications (especially replacement of non-technical terms with more familiar ones) would improve ELLs understanding in our context.

Furthermore, a major finding in this study was that terms were better understood when found in a specific context (science and everyday) more than when the context was absent (one word synonym without a context). This suggests that the level of non-technical term comprehension can be improved when language is taught contextually. One of the possible explanations in the literature is that students tend to use contextual clues to assist them in making meaning of terms. As such, it is crucial for students to explicitly learn how to use contextual clues to derive the meaning of words in texts. So instead of asking students to look up the meaning of unfamiliar non-technical terms, both science and language teachers can assist students in learning how to derive their meaning from contextual clues provided in the text.

Attention also needs to be placed on expanding students' exposure to non-technical terms in various contexts. This task is not limited only to language teachers. In fact, learning of English language should extend outside the English classroom to include other subject areas taught in a second language such as science (Ali & Ismail, 2006, Tong et al., 2014). One suggestion for language teachers is to refer to science and technology contexts as a way to improve students' understanding of non-technical terms used in science. In other words, instead of only focusing on the meaning of terms as found in their English texts, language teachers can highlight how the same terms are used differently in science. Similarly, science teachers can incorporate brief activities where students differentiate between the everyday meaning of a term (used in English) and the science one. Such activities, whether performed in science or English class, can help students first become aware that terms' meanings in English sometimes differ than in science and second expand their vocabulary. Furthermore, there is a need to reconsider what is being read in English language classes. Specifically, students may benefit from reading a wide range of non-fiction genres (such as science related texts) in English language classes. In fact, many researches have concluded that reading instruction that focuses on language skills and is separated from content area language placed ELLs at a disadvantage of improving both language acquisition and content area knowledge (Greenleaf & Hinchman, 2009; Haycock, 2001; Lee & Spratley, 2010)

Another interesting finding is that ELLs were familiar with the everyday meaning of non-technical terms more than their science one. This finding suggests that even when students confirm their understanding of a non-technical term in science class, they may be relating it to its everyday meaning and not its scientific one. As such, science teachers need to be more critical of their students' comprehension of these terms and make sure that a shared understanding of non-technical terms is established in the classroom.

Results showed that for many terms students' performance was inconsistent across grade levels. For instance one term would be difficult for Grade 9 students but easy for Grade 7 students. One possible reason for this would be that such terms are only addressed in a specific grade level and so as the years progress students have trouble recalling the meaning of the term. As such, there is a need to reconsider how science curricula are organized and think about ways in which non-technical terms are consistently re-introduced in all grade levels. School administrators may even choose to reconsider teaching science as a general science course and revert to assigning a course for each of the fields of science. On the one hand, this strategy may give students more opportunities to discuss field specific non-technical terms. On the other hand, exposure to common terms in each of the fields allows more chances to emphasize their meanings and possibly reduce the problem of inconsistency in understanding non-technical terms.

Furthermore, PSAT scores were found to be significant predictors of ELLs' performances on the questionnaire and indirectly their understanding of non-technical terms. This finding is interesting since it suggests that PSAT scores can be used to identify students struggling in reading and understanding science texts. Instead of merely relying on these scores as indications for students' performance on the SAT, science and English teachers can utilize them as evidence for students' reading comprehension skills in science.

Recommendations for Future Research

No other study has investigated the comprehension of science texts for middle school ELLs in a Lebanese school. As such, more research is needed in this area. Specifically, data for this study was obtained from one Lebanese private school in Beirut, which mainly caters to students of middle and high SES. More research is therefore needed to explore non-technical term understanding for ELLs belonging to low SES communities. Future research can also focus on comparing the effect of difference in socio-economic status on the comprehension of non-technical terms in science. Since this study was limited to one school in Beirut, the generalizability of results is limited. Given the little research on the comprehension of non-technical terms in science for ELLs in Lebanon, future studies can expand the scope of this research to include more private schools in Beirut and other areas in Lebanon.

Furthermore, little is also known about the effect of curriculum on students' comprehension of non-technical terms in science. Private schools in Lebanon offer a variety of programs such as the American program, Lebanese and International Baccalaureate. Each of these programs has a different curriculum and as such requires the use of different science textbooks for the same grade level. Students enrolled in the Lebanese program are therefore exposed to non-technical terms that are different than those enrolled in other programs. Given these differences, it would be interesting to explore whether there is any relationship between the choice of curriculum and students' understanding of non-technical terms in science.

The Lebanese curriculum dictates that science in middle school (Grade 7 through Grade 9) is divided into three main fields (physics, life science and chemistry) each of which is instructed as a separate course. Instruction in each course focuses on field specific topics and their associated technical and non-technical terms. In contrast, the American program adopted in the school under study does not require this level of specialization. Middle school students (Grade 6 through Grade 9) are required to attend five general science classes per week. For each grade level, topics related to physics, life science and chemistry are selected and instructed at different times of the academic year. For instance, during the first three months of the academic year, the focus of instruction in each grade level is on life science topics. Instruction in the following three months then shifts to chemistry or physics topics. As such, contrary to those enrolled in the Lebanese program, students attending general science courses are limited in their exposure to the terminology and associated non-technical terms of a particular field. Given this difference, there is a need to compare the comprehension of terms for ELLs taking specialized field-specific courses with ones taking general science courses. The aim is to examine the effect of focused use of specialized language in each scientific field on the comprehension of non-technical terms.

Results in this study showed a positive correlation between non-technical terms comprehension and students' performance on the critical reading section of the PSAT. This finding implies that PSAT critical reading scores can be used as measures to identify whether students have trouble understanding non-technical terms in science texts. However, due to the small sample tested, more research is needed to further explore the connection between non-technical term understanding and standardized tests. Future research can also investigate whether such a correlation exists with other standardized tests commonly used in Lebanon such as the SAT, TOEFL or standardized science assessments such as the GCE and IGCSE.

The problems associated with understanding non-technical terms for both ELLs and native language speakers have been explored extensively in the literature. One of the main concerns with enhancing students' understanding of these terms is to improve students' abilities to effectively read and understand science texts. Once a shared meaning of non-technical terms has been established in class, scientific concepts can be tackled with more depth, which may have a positive effect on science achievement (Ali & Ismail, 2006). Given this link, more research is needed to explore the relation between non-technical term comprehension and science achievement in the context of Arabic speaking countries such as Lebanon.

In order to further understand the effect of instruction in a second language on understanding science texts, Johnstone and Selepeng (2001) refer to an information processing model for learning. In this model, the working memory is a conscious part of the mind where new filtered information is processed and is either stored in long term memory or becomes discarded. The working memory, while limited in capacity for each individual, assumes the dual function of holding input information as well as processing it. As such, if this memory has too much information to hold then less capacity is left for processing and vice versa. In the case of ELLs, a lot of working memory is needed to transform and process the complex and unfamiliar English language to which they are exposed. Consequently, minimal learning is achieved since there is little space for holding information that could be transferred to long term memory. This framework suggests that the extensive need for processing information in science is a major factor which might explain students' difficulties in understanding science. Yet this problem is far more complex for ELLs who are faced with a dual task of processing two unfamiliar languages: the language of science itself and English. Given these difficulties, more research is needed to investigate the implications of these problems on ELLs' science achievement and the methods that can be employed to help ELLs more effectively process the scientific information in a second language.

Conclusion

The aim of this study was to investigate middle school ELLs' comprehension of non-technical terms encountered in American science textbooks. It was evident that ELLs face difficulties in understanding these terms in science textbooks which affect the learning of science. Although students' performance did slightly improve with grade, it is clear that even students at higher grades still struggle with the meaning of non-technical terms. Like other ELLs, these students face the dual challenge of processing both the language of science as well as English. As such, more attention needs to be placed on explicit instruction of these terms in science class and wider exposure to non-fiction texts. Furthermore, standardized tests such as the PSAT were found to be good predictors of students' understanding of non-technical terms and can therefore be used as tools to identify struggling students.

REFERENCES

Abdul-Hamid, S., & Samuel, M. (2012). Reading scientific texts: Some challenges faced by EFL readers. *International Journal of Social Science and Humanity, 2*(6), 509.

Ali, M., & Ismail, Z. (2006). Comprehension level of non-technical terms in science: Are we ready for science in English. *The Asia Pacific Journal of Educators and Education (Formerly Known as Journal of Educators and Education), 21*(1), 1-11.

Arden-Close, C. (1993). Language problems in science lectures to non-native speakers. *English for Specific Purposes, 12*(3), 251-261. doi:10.1016/0889-4906(93)90005-9

Bailey, A. L., Huang, B. H., Shin, H. W., Farnsworth, T., & Butler, F. A. (2007). Developing academic english language proficiency prototypes for 5th grade reading: Psychometric and linguistic profiles of tasks. CSE technical report 727. *National Center for Research on Evaluation, Standards, and Student Testing (CRESST),*

Baumann, J. F., Kame'enui, E. J., & Ash, G. E. (2003). Research on vocabulary instruction: Voltaire redux. *Handbook of Research on Teaching the English Language Arts, 2*, 752-785.

Best, R. M., Rowe, M., Ozuru, Y., & McNamara, D. S. (2005). Deep-level comprehension of science texts: The role of the reader and the text. *Topics in Language Disorders, 25*(1), 65-83.

Bird, E., & Welford, G. (1995). The effect of language on the performance of second-language students in science examinations. *International Journal of Science Education, 17*(3), 389-397. doi:10.1080/0950069950170309

Bradley, J., Cohn, E., Balch, D. C., & Cohn, S. (2004). Determinants of undergraduate GPAs: SAT scores, high-school GPA and high-school rank. *Economics of Education Review*, 23(6), 577-586.

Bravo, M. A., & Cervetti, G. N. (2014). Attending to the language and literacy needs of english learners in science. *Equity & Excellence in Education, 47*(2), 230-245. doi:10.1080/10665684.2014.900418

Bunce, D. M., & Hutchinson, K. D. (1993). The use of the GALT (group assessment of logical thinking) as a predictor of academic success in college chemistry. *Journal of Chemical Education, 70*(3), 183.

Byrne, M., Johnstone, A. H., & Pope, A. (1994). Reasoning in science: A language problem revealed? *School Science Review, 75*(272), 103.

Carnine, L., & Carnine, D. (2004). The interaction of reading skills and science content knowledge when teaching struggling secondary students. *Reading & Writing Quarterly, 20*(2), 203-218.

Cassels, J., & Johnstone, A. (1983). The meaning of words and the teaching of chemistry. *Education in Chemistry, 20*(1), 10-11.

Cassels, J. R. T., & Johnstone, A. H. (1984). The effect of language on student performance on multiple choice tests in chemistry. *Journal of Chemical Education*, 61(7), 613. doi:10.1021/ed061p613

Cassels, J., & Johnstone, A. H. (1985). *Words that matter in science: A report of a research exercise* Royal Society of Chemistry.

Childs, P. E., & O'Farrell, F. J. (2003). Learning science through English: An investigation of the vocabulary skills of native and non-native English speakers in international schools. *Chem.Educ.Res.Pract, 4*(3), 233-247. doi:10.1039/B3RP90015K

Clark, J. (1997). Beyond the turgid soil of science prose: STAP's attempt to write more accessible science text materials in general science. *Proceedings of the Fifth Annual Meeting of the Southern African Association for Research in Science and Mathematics Education,* 390-396.

Cohen, A., Glasman, H., Rosenbaum-Cohen, P. R., Ferrara, J., & Fine, J. (1979). Reading English for specialized purposes: Discourse analysis and the use of student informants. *TESOL Quarterly, 13*(4), 551-564.

Craig, M. T., & Yore, L. D. (1996). Middle school students' awareness of strategies for resolving comprehension difficulties in science reading. *Journal of Research and Development in Education, 29*(4), 226-238.

Cummins, J. (2000). *Language, power and pedagogy: Bilingual children in the crossfire*. Toronto: Multilingual Matters Ltd.

Dandashly, N. M., & American University of Beirut. Faculty of Arts and Sciences. Department of Education. (2007). *Problems of non-native speakers of English when reading biology text*

Dillon, J. (2009). On scientific literacy and curriculum reform. *International Journal of Environmental and Science Education, 4*(3), 201-213.

Doidge, M. (1997). How readable is your biology textbook? can you be sure. *Proceedings of the Fifth Annual Meeting of the Southern African Association for Research in Science and Mathematics Education. Johannesburg, South Africa,* 396-400.

Eggins, S. (2004). *An introduction to systemic functional grammar* (2nd ed.). New York, NY: Continuum.

Eggins, S., Wignell, P., & Martin, J. R. (1993). The discourse of history: Distancing the recoverable past. *Register analysis: Theory and practice*, 75-109.

Eisenhart, M., Finkel, E., & Marion, S. F. (1996). Creating the conditions for scientific literacy: A re-examination. *American Educational Research Journal*, *33*(2), 261-295.

Esseili, F. (2014). English language teaching in Lebanese schools: Trends and challenges. *Teaching and learning English in the Arabic-speaking world*, 101-114.

Fang, Z. (2005). Scientific literacy: A systemic functional linguistics perspective. *Science Education*, *89*(2), 335-347.

Fang, Z. (2006). The language demands of science reading in middle school. *International Journal of Science Education, 28*(5), 491-520.

Fang, Z., & Schleppegrell, M. J. (2010). Disciplinary literacies across content areas: Supporting secondary reading through functional language analysis. *Journal of Adolescent & Adult Literacy, 53*(7), 587-597.

Fang, Z., & Wei, Y. (2010). Improving middle school students' science literacy through reading infusion. *The Journal of Educational Research, 103*(4), 262-273.

Farrell, M. P., & Ventura, F. (1998). Words and understanding in physics. *Language and Education, 12*(4), 243-253. doi:10.1080/09500789808666752

Gardner, P. (1972). Words in science. Melbourne: Australian Science Education Project

Gardner, R. C. (1976). Second language learning: A social psychological perspectives. *Canadian Modern Language Review, 32*(3), 198-213.

Gardner, P. L. (1977). Logical connectives in science: A summary of the findings. *Research in Science Education, 7*(1), 9-24. doi:10.1007/BF02643108

Gardner, P. L., Schafe, L., Myint Thein, U., & Watterson, R. (1976). Logical connectives in science: Some preliminary findings. *Research in Science Education, 6*(1), 97-108. doi:10.1007/BF02558654

Gee, J. P. (2004). Language in the science classroom: Academic social languages as the heart of school-based literacy. In E. W. Saul (Eds), *Crossing borders in literacy and science instruction: Perspectives on theory into practice* (pp. 13–32). Newark, DE: International Reading Association & Arlington, VA: NSTA Press.

Glover, D., Kolb, D., & Taylor, M. (1991). Another option for chemistry dropouts. *Journal of Chemical Education*, 68(9), 762. doi:10.1021/ed068p762

Greenleaf, C. L., & Hinchman, K. (2009). Reimagining our inexperienced adolescent readers: From struggling, striving, marginalized, and reluctant to thriving. *Journal of adolescent & adult literacy*, 53(1), 4-13.

Greenleaf, C., Schoenbach, R., Cziko, C., & Mueller, F. (2001). *Apprenticing adolescents to academic literacy*. Harvard Educational Review, 71, 79–129

Groves, F. H. (1995). Science vocabulary load of selected secondary science textbooks. *School Science and Mathematics, 95*(5), 231-235. doi:10.1111/j.1949-8594.1995.tb15772.x

Halliday, M. A. (1993). Towards a language-based theory of learning. *Linguistics and Education, 5*(2), 93-116.

Halliday, M., & Matthiessen, C. (2004). *An introduction to functional grammar* (3rd ed.). London: Arnold.

Halliday, M. A. K., & Martin, J. R. (2003). *Writing science: Literacy and discursive power*. Taylor & Francis.

Hand, B. M., Prain, V., & Yore, L. D. (2001). Sequential writing tasks' influence on science learning. In P. Tynjala, L. Mason, & K. Lonka (Eds.), *Writing as a learning tool: Integrating theory and practice* (pp. 105-129). Dordrecht, The Netherlands: Kluwer.

Hasan, R., & Martin, J.R. (Eds). (1989). *Language development: Learning language, learning culture. Meaning and choice in language: Studies for Michael Halliday*. Norwood, NJ: Ablex

Haycock, K. (2001). *Closing the achievement gap*. Educational Leadership, 58(6), 6–11. Retrieved from http://www.ascd.org/readingroom/edlead/0103/haycock.html

Higgins, J. J. (1966). Hard facts: Notes on teaching english to science students. *English Language Teaching*, 21(1), 55.

Jaisen, P. G. (2011). What do you mean that "strong" doesn't mean "powerful"? *Journal of Chemical Education, 88*(9), 1247.

Jasien, P. G. (2010). You said "neutral", but what do you mean? *Journal of Chemical Education, 87*(1), 33.

Johnstone, A. H. (1991). Why is science difficult to learn? things are seldom what they seem. *Journal of Computer Assisted Learning, 7*(2), 75-83. doi:10.1111/j.1365-2729.1991.tb00230.x

Johnstone, A. H., & Selepeng, D. (2001). a language problem revisited. *Chem.Educ.Res.Pract, 2*(1), 19-29. doi:10.1039/B0RP90028A

Lara-Alecio, R., Tong, F., Irby, B. J., Guerrero, C., Huerta, M., & Fan, Y. (2012). The effect of an instructional intervention on middle school English learners' science and English reading achievement. *Journal of Research in Science Teaching, 49*(8), 987-1011. doi:10.1002/tea.21031

Lead States, N. G. S. S. (2013). *Next generation science standards: For states, by states*. Washington, DC: The National Academies Press

Lee, C. D., & Spratley, A. (2010). *Reading in the disciplines: The challenges of adolescent literacy*. New York, NY: Carnegie Corporation of New York.

Lee, O. (2005). Science education with English language learners: Synthesis and research agenda. *Review of Educational Research, 75*(4), 491-530.

Lee, O., Maerten-Rivera, J., Penfield, R. D., LeRoy, K., & Secada, W. G. (2008). Science achievement of English language learners in urban elementary schools: Results of a first-year professional development intervention. *Journal of Research in Science Teaching, 45*(1), 31-52.

Lee, O., Quinn, H., & Valdés, G. (2013). Science and language for English language learners in relation to next generation science standards and with implications for common core state standards for English language arts and mathematics. *Educational Researcher, 42*(4), 223-233.

Lemke, J. L.(1990). *Talking science: Language, learning, and values*. Norwood NJ: Ablex Publishing Corporation.

Lewis, S. E., & Lewis, J. E. (2007). Predicting at-risk students in general chemistry: comparing formal thought to a general achievement measure. *Chemistry Education Research and Practice, 8*(1), 32-51.

MacDonald, C.A. (1990*). School Based Learning Experiences: A Final Report of the Threshold Project*. Pretoria: Human Sciences Research Council

Marshall, S., & Gilmour, M. (1990). Problematical words and concepts in physics education: A study of Papua New Guinean students' comprehension of non-technical words used in science. *Physics Education, 25*(6), 330-337. doi:10.1088/0031-9120/25/6/309

Marshall, S., Gilmour, M., & Lewis, D. (1991). Words that matter in science and technology.*Research in Science & Technological Education*, 9(1), 5-16. doi:10.1080/0263514910090102

Martin, J. R., & Rose, D. (2007). *Working with discourse: Meaning beyond the clause* (2nd ed.). London: Continuum.

McNamara, D. S., O'Reilly, T. P., Best, R. M., & Ozuru, Y. (2006). Improving adolescent students' reading comprehension with istart. *Journal of Educational Computing Research*, 34(2), 147-171. doi:10.2190/1RU5-HDTJ-A5C8-JVWE

Nist, S.L., Holschuh, J.L. and Sharman, S.J. (1995) 'Making the grade in undergraduate biology courses: factors that distinguish high and low achievers', presented at the 1995 meeting of the American Educational Research Association.

Norris, S. P., & Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education, 87*(2), 224-240.

NRC (National Research Council) (1996) National Science Education Standards (Washington, DC: National Academy Press).

NRC (National Research Council) (2012) National Science Education Standards (Washington, DC: National Academy Press).

O'Rafferty, M. E. (1989). Pupil understanding of non-technical vocabulary in science textbooks. *Irish Educational Studies, 8*(2), 191-205. doi:10.1080/0332331890080215

Osborne, J. (2002). Science without literacy: A ship without a sail? *Cambridge Journal of Education, 32*(2), 203-218. doi:10.1080/03057640220147559

Pearson, P. D., Moje, E., & Greenleaf, C. (2010). Literacy and science: Each in the service of the other. *Science (New York, N.Y.), 328*(5977), 459-463. doi:10.1126/science.1182595 [doi]

Pickersgill, S., & Lock, R. (1991). Student understanding of selected Non-Technical words in science. *Research in Science & Technological Education, 9*(1), 71-79. doi:10.1080/0263514910090107

Proctor, C. P., August, D., Carlo, M. S., & Snow, C. (2006). The intriguing role of Spanish language vocabulary knowledge in predicting English reading comprehension. *Journal of Educational Psychology, 98*(1), 159.

Proctor, C. P., Carlo, M., August, D., & Snow, C. (2005). Native Spanish-speaking children reading in English: Toward a model of comprehension. *Journal of Educational Psychology, 97*(2), 246.

Pyburn, D. T., Pazicni, S., Benassi, V. A., & Tappin, E. E. (2013). Assessing the relation between language comprehension and performance in general chemistry. *Chem.Educ.Res.Pract, 14*(4), 524-541. doi:10.1039/C3RP00014A

Radwan, N. K., & American University of Beirut. Faculty of Arts and Sciences.Department of Education. (2013). *The science textbook: Reading problems faced by Lebanese elementary students*

Ramist, L., Lewis, C., & Jenkins, L. M. (1997*). Students with discrepant high school GPA and SAT scores.* (Research Report RS-01). New York: The College Board. Retrieved from: http://research.collegeboard.org/sites/default/files/publications/2012/7/researchinreview-1997-1-students-discrepant-hs-gpa-sat.pdf

Reiss, M. J., Millar, R., & Osborne, J. (1999). Beyond 2000: Science/biology education for the future. *Journal of Biological Education*, 33(2), 68-70. doi:10.1080/00219266.1999.9655644

Rollnick, M. (2000). Current issues and perspectives on second language learning of science. *Studies in Science Education, 35*(1), 93-121. doi:10.1080/03057260008560156

Roth, W., & Lawless, D. (2002). Science, culture, and the emergence of language. *Science Education, 86*(3), 368-385.

Ryf, A., & Cleghorn, A. (1997). The language of science: Text talk and teacher talk in second language settings. *Proceedings of the Fifth Annual Meeting of the Southern African Association for Research in Science and Mathematics Education*, 437-441.

Schleppegrell, M. J. (2001). Linguistic features of the language of schooling. *Linguistics and Education, 12*(4), 431-459.

Shaaban, K., & Ghaith, G. (1999). Lebanon's language-in-education policies: From bilingualism to trilingualism. *Language Problems and Language Planning, 23*(1), 1-16.

Shaaban, K., & Ghaith, G. (2002). University students' perceptions of the ethnolinguistic vitality of arabic, french and english in lebanon. *Journal of Sociolinguistics, 6*(4), 557-574.

Slater, B. C. (1978). *A study of textual factors influencing the ability of secondary school pupils to comprehend and make inferences from scientific prose: a propositional approach to sentence complexity* (Doctoral dissertation, University of Oxford).

Snow, C. (2002). *Reading for understanding: Toward an R&D program in reading comprehension*. Santa Monica: RAND Corporation. doi:10.7249/mr1465oeri

Snow, C. E. (2010). Academic language and the challenge of reading for learning about science. *Science*, *328*(5977), 450-452. doi:10.1126/science.1182597

Songer, N. B., & Linn, M. C. (1991). How do students' views of science influence knowledge integration? *Journal of Research in Science Teaching, 28*(9), 761-784. doi:10.1002/tea.3660280905

Sutton, C. (1998). New perspectives on language in science. *International Handbook of Science Education, 1*, 27-38.

Taboada, A. (2012). Relationships of general vocabulary, science vocabulary, and student questioning with science comprehension in students with varying levels of English proficiency. *Instructional Science, 40*(6), 901-923.

Taboada, A., & Rutherford, V. (2011). Developing reading comprehension and academic vocabulary for English language learners through science content: A formative experiment. *Reading Psychology, 32*(2), 113-157.

Taboada, A., Bianco, S., & Bowerman, V. (2012). Text-based questioning: A comprehension strategy to build English language learners' content knowledge. *Literacy Research & Instruction, 51*(2), 87-109. doi:10.1080/19388071.2010.522884

Tao, P. K. (1994). Comprehension of non-technical words in science: The case of students using a 'foreign' language as the medium of instruction. *Research in Science Education, 24*(1), 322-330. doi:10.1007/BF02356359

Todd-Trimble, Mary, Louis Trimble & Karl Drobnic (Eds.). 1978. *English for specific purposes: science and technology,* Corvallis Oregon: English Language Institute, Oregon State University

Tong, F., Irby, B. J., Lara-Alecio, R., & Koch, J. (2014). Integrating literacy and science for english language learners: From learning-to-read to reading-to-learn. *The Journal of Educational Research,* (ahead-of-print), 1-17.

Towse, P., & Prophet, B. (1999). Pupils' understanding of some non-technical words in science. *The School Science Review, 81*(295), 79.

Trimble, M. T., Trimble, L., & Drobnic, K. (1978). *English for specific purposes: Science and technology* English Language Institute, Oregon State University.

UNESCO (1994) The Project 2000 + Declaration. [Brochure] (Paris, France: UNESCO).

Van den Broek, P. (2010). Using texts in science education: Cognitive processes and knowledge representation. *Science (New York, N.Y.), 328*(5977), 453-456. doi:10.1126/science.1182594 [doi]

Verhoeven, L. (2000). Components in early second language reading and spelling. *Scientific Studies of Reading, 4*(4), 313-330.

Vygotsky, L. S. (1962). *Thought and language.* Cambridge, MA: MIT Press.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge MA: Harvard University Press.

Webb, P. (2010). Science education and literacy: Imperatives for the developed and developing world. *Science (New York, N.Y.), 328*(5977), 448-450. doi:10.1126/science.1182596 [doi]

Wellington, J., & Osborne, J. (2001). *Language and literacy in science education* McGraw-Hill. Buckingham: Open University Press.

Wells, G. (1994). The complementary contributions of Halliday and Vygotsky to a "language-based theory of learning". *Linguistics and Education, 6*(1), 41-90. doi:10.1016/0898-5898(94)90021-3

Wright, J. D. (1982). The effect of reduced readability text materials on comprehension and biology achievement. *Science Education, 66*(1), 3-13. doi:10.1002/sce.3730660103

Yore, L. D., Craig, M. T., & Maguire, T. O. (1998). Index of science reading awareness: An interactive-constructive model, test verification, and grades 4–8 results. *Journal of Research in Science Teaching, 35*(1), 27-51.

Yore, L., Bisanz, G. L., & Hand, B. M. (2003). Examining the literacy component of science literacy: 25 years of language arts and science research. *International Journal of Science Education, 25*(6), 689-725.

APPENDIX I

DEMOGRAPHICS

The purpose of this questionnaire is for you to provide some basic background information about yourself. Please circle the answer that applies.

1. **Gender:**
   A. Female
   B. Male

2. **Grade/Year:**
   A. Grade 6/Year 6
   B. Grade 7/Year 7
   C. Grade 8/Year 8
   D. Grade 9/Year 9

3. **Age:**
   A. 9-10
   B. 11-12
   C. 13-14
   D. 15-16

4. **Your nationality (You can pick more than one)**
   A. Lebanese
   B. Lebanese Armenian
   C. Syrian
   D. Iraq
   E. Other : ____________________ (please specify)

5. **What is your father's nationality? (You can pick more than one)**
   A. Lebanese
   B. Lebanese Armenian
   C. Syrian
   D. Iraq
   E. Other : ____________________ (please specify)

6. **What is your mother's nationality? (You can pick more than one)**
   A. Lebanese
   B. Lebanese Armenian
   C. Syrian
   D. Iraq
   E. Other : ___________________ (please specify)

7. **What language are you most comfortable speaking?**
   A. Arabic
   B. Armenian
   C. English
   D. French
   E. Other : ___________________ (please specify)

8. **What language are you most comfortable reading/writing?**
   A. Arabic
   B. Armenian
   C. English
   D. French
   E. Other : ___________________ (please specify)

9. **In what language do you speak at home with your family?**
   A. Arabic
   B. Armenian
   C. English
   D. French
   E. Other : ___________________ (please specify)

10. **In what language do you speak with your friends?**
   A. Arabic
   B. Armenian
   C. English
   D. French
   E. Other : ___________________ (please specify)

APPENDIX II

NON-TECHNICAL VOCABULARY TESTS

(PINK)

Directions: Read the questions carefully and circle the correct answer. Please do not skip any question.

Note: There is only one correct answer.

1. The exam grade was a <u>percentage</u>. This means it was

    a) Given to all students
    b) A large number
    c) The average of the class
    d) Out of hundred

2. Which sentence uses the word <u>excite</u> correctly?

    a) Just the thought of the party began to excite him
    b) Dogs should not be allowed to excite on sidewalks
    c) The freshly made tea was left to excite to improve its flavor
    d) The girl began to excite a page from her book

3. The builder is a <u>capable</u> work-man. This means he

    a) Never leaves a mess
    b) Works very hard
    c) Can do his job
    d) Always takes his time

4. Which sentence uses the word <u>repel</u> correctly?

    a) "Repel these bad laws" shouted the crowd
    b) The defenders managed to repel the attackers
    c) To repel the bicycle was the only way to make it work
    d) It was such an enjoyable sweet that I felt repel to have another

5. The rainfall was <u>average</u> for May. This means it was

    a) The highest ever for May
    b) About normal for May
    c) The lowest ever for May
    d) Higher than any other month

6. The girl brought an appropriate present to her friend. This means the present was

    a) Suitable
    b) Expensive
    c) Big
    d) Small

7. Which sentence uses the word characteristic correctly?

    a) Two of the characteristic sites in Lebanon are Baalbek temples and the Jeitta Grotto.
    b) The man was recognized by his characteristic walk.
    c) Three characteristic days were needed to repair the damage
    d) The company said that all characteristic expenses were paid.

8. The student used the results of the experiment to classify the compounds. This means the student:

    a) Was able to identify the compounds
    b) Set out a clear report of the investigation
    c) Was able to put the compounds into groups
    d) Placed the compounds in tables

9. The components of a car are

    a) The parts of which the car is made
    b) The fuel needed to run the car
    c) The people who own it
    d) The people who drive it

10. The colors were a contrast to each other. This means that

    a) Were unlike each other
    b) Were of similar shade
    c) Had the same brightness
    d) Varied in their texture

11. A fire extinguisher is a useful device. This means that it is

    a) An appliance
    b) A luxury
    c) An inventory
    d) A method

12. Which sentence uses the word diagnosed correctly?

a) The nurse saw what was wrong and diagnosed some medicine
b) The doctor saw the patient and diagnosed the chicken pox
c) The nurse diagnosed the patient's temperature
d) The chemist diagnosed the prescription

13. A diversity of clothes was on display in the window. This means

a) There was a variety of clothes
b) The clothes were of similar style
c) The colors of the clothes were matched
d) Contrasting colors showed off the clothes

14. Which of the following sentences uses the word effect correctly?

a) The teacher could not effect the work of the pupils
b) The effect of heating water is that it boils
c) It took considerable effect to move the boulder
d) He though his smile would effect everyone

15. Certain material can emit radiations. This means that these material

a) Transfer radiation within their structure
b) Take in radiation
c) Give out radiation
d) Convert radiation into another form of energy

16. The word "estimate" means

a) Accept
b) Obtain
c) Clarify
d) Calculate

17. When you climb the stairs, you exert yourself. This means you

a) Use your strength
b) Make yourself tired
c) Remove yourself from ground level
d) Raise yourself

18. Which sentence uses the word <u>external</u> correctly?

a) The Greek gods thought they were external
b) The external TV antenna was placed on the roof
c) The heart and lungs are external organs
d) The dinosaurs are now external

19. Which sentence uses the word <u>agent</u> correctly?

a) In recent years, he felt his father had been agent rapidly.
b) Her ambition was to be the company's agent in Beirut.
c) Because of his agent, he was difficult to understand
d) He did his best to avoid fights that might develop into an agent.

20. The word <u>complex</u> means

a) Simple
b) Concentrated
c) Natural
d) Complicated

21. Which sentence uses the word <u>composition</u> correctly?

a) There was no composition for the price of senior citizens
b) The composition of bricks depends on the materials used to make them
c) School is not composition when you are 17 years old
d) The guard dog moved around the composition

22. The <u>concept</u> was difficult to grasp because he had not been listening to the teacher talking. This means

a) The idea was difficult
b) The device was difficult
c) The experiment was difficult
d) The method was difficult

23. She decided to <u>contribute</u> to charity. This means she decided to

a) Give them some help
b) Ask them for help
c) Stop giving them help
d) Avoid giving them help

24. Which sentence uses the word <u>converge</u> correctly?

a) The builder gave an estimate of the cost to converge the small bedroom into a bathroom
b) The officers discussed how the troops would converge on the town
c) The math homework was to learn the theory and its converge
d) Since all of them were interesting in fishing, the guests found it easy to converge on this subject over their meal

25. The tear in the coat was impossible to <u>detect</u>. This means

a) The tear could not be seen
b) The coat could not be repaired
c) The damage had been very slight
d) The coat was now ugly

26. Which sentence uses the word <u>devise</u> correctly?

a) They devise him because he is so selfish
b) The hairstylist tried to devise a suitable hairstyle for her
c) It was a very devise plan to rob the bank
d) The cat was a very devise mother to her kittens

27. The light <u>dispersed</u> as it passed through the window. This means the light

a) Became brighter
b) Disappeared
c) Became scattered
d) Became focused

28. The student was trying to find out the most <u>efficient</u> way of measuring the growth of plants. This means the student is trying to find the

a) Easiest way
b) Most impressive
c) Best
d) Commonest

29. <u>Essential</u> can mean

a) Permanent
b) Particular
c) Removable
d) Necessary

30. Which sentence uses the word excess correctly?

a) The sign above the door indicated that it was the excess
b) The girl used excess jam on her sandwich
c) Her homework was well done in fact it was excess
d) It is excess to wear safety glasses when working with fire

31. Which sentence uses the word "factor" correctly?

a) He was fortunate that the wind was always in his factor during the sail
b) Rainfall is a major factor in the growth of plants
c) During sale, the coat was only a factor of its original price
d) His injuries from the accident included a factor of his rib

32. The chemical reaction was designed to generate steam. This means it

a) Needed steam
b) Examined steam
c) Made steam
d) Reduced steam

33. The word "illustrate" means

a) Gloss over
b) Light up
c) Leave out
d) Make clear

34. The sound of the impact was heard in the garden. This means the sound from the

a) Collide
b) Conclusion
c) Product
d) Origin

35. Which sentence uses the word "influence" correctly?

a) His new gained influence meant he could now live a successful life
b) The editor had considerable influence on the journalist
c) In the first influence, she decided to go abroad but she later changed her mind
d) At the influence of the two rivers, the current was very strong

36. The initial step of the experiment involved adding acid. This means that the acid was added

a) Carefully
b) Last
c) First
d) Throughout

37. Which sentence uses the word "interpret" correctly?

a) The student was asked to interpret the teacher
b) The art teacher asked the girl to interpret her painting
c) In the drawing the place where the lines interpret is the center of the figure
d) The fight ended when the police were asked to interpret

38. The speed limit was 40 miles per hour. This means that cars had to travel

a) At no more than 40 miles per hour
b) At exactly 40 miles per hour
c) Between 35 and 40 miles per hour
d) At an average of 40 miles per hour

39. Which sentence uses the word "linear" correctly?

a) The ship linear sailed into port
b) The car's movement was linear
c) The speed linear on the car was 40 miles per hour
d) The best linear table cloth was used to impress the guest

40. The word "logic" means

a) Evidence
b) The study of results
c) Technique
d) The science of reasoning

41. Which sentence uses the word "negative" correctly?

a) Management had been able to negative the agreement
b) Since she did not want to go to the party, her answer was negative
c) The rainfall during the summer was negative
d) His behavior was so bad that he was described as a negative person

42. Which sentence uses the word "probability" correctly?

a) After going to court, he was put on probability
b) The probability of everyone giving up smoking is very small
c) Children from poor homes can be a probability
d) The best painting in the contest won a probability

43. The experiment was designed to study the rate of the reaction. This means it was to study

a) The effect of changing the chemicals
b) The results of the experiment
c) The speed of the reaction
d) The end of the reaction

44. The word "reference" means

a) Reasoning
b) A reconsideration of thought
c) Principles of a procedure
d) Direction to where information may be found

45. Ahmad was tall relative to Samir. This means

a) Compared
b) As
c) Friend
d) brother

46. The weather conditions were relevant to the cause of the accident. This means the accident was

a) Affected by the weather
b) Caused by the weather
c) Nothing to do with weather
d) Not affected by the weather

47. At the factory he was in charge of the sequence of reactions in the chemical process. This means he was in charge of

a) People adding chemicals
b) Quality of the reactions
c) Order of the reactions
d) Planning

48. The word "source" means

a) Measurement
b) Conclusion
c) Product
d) Origin

49. He did not feel that the canned juice was up to standard. This means he felt it

a) Reduced in quality
b) Reduced in price
c) Not yet ready to drink
d) Not in the usual container

50. The strong taste of the food was able to stimulate her taste buds on her tongue. This means the taste

a) made her taste buds work
b) didn't make her taste buds work
c) annoyed her taste buds
d) smothered her taste buds

51. Which sentence uses the word "substitute" correctly?

a) He is in the navy and works on a nuclear substitute
b) When knitting, she would substitute yarn for wool
c) Where the substitute had taken place, a large hole developed in the road
d) She has a substitute amounts of money and was able to spend freely

52. Which sentence uses the word "symmetrical" correctly?

a) The potatoes were symmetrical not boiling
b) The left and right halves of picture were symmetrical
c) Miles and meters and not symmetrical units
d) The length of the table had a symmetrical of 10 mm

53. The teacher praised the system shown in the experiment. This means the teacher praised

a) The student's thinking
b) The student's technique
c) How all the parts of the experiment had been organized
d) The results of the experiment

54. The word "<u>theory</u>" means

a) A fact
b) A procedure
c) A system
d) A point of view

55. The word "<u>valid</u>" means

a) Empty
b) Weak
c) Worthy
d) Correct

NON-TECHNICAL VOCABULARY TEST (BLUE)

Directions: Read the questions carefully and circle the correct answer. Please do not skip any question.

Note: There is only one correct answer.

1. The exam grade was a percentage. This means it was

   a) Given to all students
   b) A large number
   c) The average of the class
   d) Out of hundred

2. Which sentence uses the word excite correctly?

   a) Just the thought of the party began to excite him
   b) Dogs should not be allowed to excite on sidewalks
   c) The freshly made tea was left to excite to improve its flavor
   d) The girl began to excite a page from her book

3. The builder is a capable work-man. This means he

   a) Never leaves a mess
   b) Works very hard
   c) Can do his job
   d) Always takes his time

4. Which sentence uses the word repel correctly?

   a) "Repel these bad laws" shouted the crowd
   b) The defenders managed to repel the attackers
   c) To repel the bicycle was the only way to make it work
   d) It was such an enjoyable sweet that I felt repel to have another

5. The rainfall was average for May. This means it was

   a) The highest ever for May
   b) About normal for May
   c) The lowest ever for May
   d) Higher than any other month

6. Water was an appropriate liquid to dissolve the compound sodium chloride. This means that

   a) Water was suitable
   b) The water reacted with the sodium chloride
   c) The water was too expensive
   d) Sodium Chloride did not dissolve

7. The word "characteristic" means

   a) Numerical fact
   b) Specific quality
   c) Similar property
   d) Small quantity

8. Classify the collection of seashells. This means

   a) Clean them
   b) Count them
   c) Put them in groups
   d) Paint them

9. The system did not work because of a specific component. This means that

   a) A part did not work
   b) The person in charge did not do his job
   c) The timing was wrong
   d) The design was wrong

10. By organizing the results of the experiment, the student was able to contrast between the types of substances. This means the student was able to

    a) Point out differences
    b) Point out similarities
    c) Identify patterns
    d) Identify substances

11. To try to get the experiment to work better, the scientist tried many devices in the system. This means the scientist tried different

    a) appliances
    b) methods
    c) plans
    d) solutions

12. The word "diagnose" means

a) Know
b) Infer
c) Cut across
d) Go round

13. The class is studying diversity of plant life in Beirut. This means they are looking

a) At the many types of plants
b) For new kinds of plants
c) At the rate of growth of plants
d) For plants they can eat

14. The word "effect" means

a) Attack
b) Result
c) Frequent
d) Change

15. A lamp will emit blue light. This means it

a) Cannot give out blue light
b) Uses blue light
c) Gives out blue light
d) Reflects blue light

16. Which sentence uses the word estimate correctly?

a) Sarah uses her calculator to estimate the answer
b) A clock can estimate the time
c) Many plants grow well in the warm sheltered corner of the estimate
d) Four rolls of wallpaper was his estimate to cover the room

17. The students exert a large force on the toy car. This means they had to

a) Apply a force
b) Stop the force
c) Collect the force
d) Measure the force

18. The word "external" means

a) Ever lasting
b) Outside
c) High
d) For color reception

19. The word "agent" means

a) That which is opposed
b) That which produces an effect
c) That which promotes recover
d) That which is formed

20. Which sentence uses the word complex correctly?

a) The girl's complex was very smooth
b) The semi-circle is a complex circle
c) It requires time to complex a task properly
d) The brain is a very complex organ

21. The word "composition" means

a) Power of understanding
b) What it is made up of
c) Act of forcing together
d) What is important

22. The student's concept of chemical bonding improved when he studies well for the material. This means the student's

a) Idea improved
b) Design improved
c) Issue improved
d) Method improved

23. At the end of the experiment, each student was asked to contribute his or her results. This means they were asked to

a) Give in their results
b) Explain their results
c) Discuss their results
d) Check their results

24. The word "converge" means

a) Reverse
b) Mover nearer together
c) Travel further apart
d) Change

25. Tests are used to detect pregnancy. This means

a) Discover
b) Detain
c) Keep in
d) Make up

26. The word "devise" means

a) Keep in
b) Think out
c) Do
d) Record

27. The crowd was able to disperse after the football match was over. This means the crowd

a) Sang and danced
b) Caused no trouble
c) Went away in all directions
d) Stayed in their seat

28. Large brooms are more efficient than small brooms for sweeping the floor. This means that large one are more

a) Difficult to use
b) Flowing
c) Capable
d) Commonly used

29. Which sentence uses the word "essential" correctly?

a) The builder thought it was more essential to use the larger truck
b) She used essential jam on her sandwich and it ran down on her face when she bit it
c) The painter thought he had essential paint to finish the job
d) It is essential to wear safety goggles when working with fire

30. The word "excess" means

a) Very good
b) More than
c) Less than
d) Not including

31. The word "factor" means

a) An event
b) An influence
c) A structure
d) An accomplishment

32. To make the old train move, it was necessary to generate steam. This means it was necessary to

a) Breakdown
b) Test
c) Make
d) Reduce

33. Which sentence uses the word "illustrate" correctly?

a) A lamp can illustrate a street
b) The boy was offended that his friend said he was illustrate
c) The girl was illustrate when her team won the prize
d) This chapter will illustrate the ideas discussed in class

34. The purpose of the experiment was to study the results of the impact of two objects. This means the objects were

a) Colliding
b) Exploding
c) Slowing down
d) Moving quickly

35. The word "influence" means

a) Imply
b) Affect
c) Conclude
d) Take in

36. Ahmad enjoyed the <u>initial</u> scene of the play most of all. This means Ahmad most enjoyed

a) The last scene
b) The most important scene
c) The first scene
d) The indoor scene

37. The word "<u>interpret</u>" means

a) Insert
b) Explain
c) Suspend
d) Consider

38. Each student had to <u>limit</u> his or her presentations to 30 minutes. This means each student had

a) Not more than 30 minutes
b) Exactly 30 minutes
c) Between 15 and 30 minutes
d) An average of 30 minutes

39. The word "<u>linear</u>" means

a) Increasing
b) In line
c) Random
d) decreasing

40. Which sentence uses the word "<u>logic</u>" correctly?

a) He died because of logic of the liver
b) Her favorite drink was logic
c) The architect delivered the logic of the house to the builder
d) The problem could only be solved by using logic

41. The word "<u>negative</u>" means

a) Greater than zero
b) Less than zero
c) Absolute
d) Formal

42. The word "probability" means

a) Possibility
b) Likelihood
c) Similarity
d) Condition

43. The man was annoyed by the rate of the dripping water. This means he was annoyed by

a) The waste of water
b) The noise of the dripping
c) The speed of the dripping
d) The splashing of water

44. Which sentence uses the word "reference" correctly?

a) The man in charge of the Library was a good reference
b) At the ceremony, the rituals were performed with much reference
c) The reference of the material was enough to make a dress
d) During our hike, we made reference to the map.

45. The purpose of the project was to study the relative benefits of changing diet on the mood of the individuals. This means the purpose was to

a) Compare diet and mood
b) Find out which one was relevant
c) Observe the diet
d) Observe the people's mood

46. The students were asked to list the relevant factors that caused global warming. This means the factors which

a) Had affected the global warming
b) Caused the global warming
c) Had nothing to do with the global warming
d) Had not affected the global warming

47. He was in charge of the sequence of events at the concert. This means he was in charge of

a) Costumes
b) Publicity
c) Order
d) Planning

48. Which sentence uses the word "source" correctly?

a) The factory made clocks as the main source
b) A good source does not hide the flavor of food.
c) The news of the death caused great pain and source
d) They walked all the way from the river source to where the two rivers meet.

49. The scientist did not feel the chemicals were up to standard. This means the scientist felt it was

a) Less in quality
b) Lower in price
c) Not yet ready to use
d) Not in the usual container

50. The presence of the powder seemed to stimulate the reaction. This means the powder seemed to

a) Trigger the reaction
b) Reverse the reaction
c) De activate the reaction
d) Smother the reaction

51. The word "substitute" means

a) Exists
b) Replace
c) Destroy
d) Remove

52. The word "symmetrical" means

a) Without shape
b) Able to be divided into two equal parts
c) Having a special shape
d) Representing

53. The hot water system means

a) The tank that holds the hot water
b) The heater in the tank that heats the water
c) All the connected tubes that carry the water
d) The taps from which the water flows

54. Which sentence uses the word "<u>theory</u>" correctly?

a) It is a theory that the earth is round
b) There is an agreed theory for starting a race
c) The theory of collecting taxes is different from country to country
d) The policeman's theory was that the crime was an act of revenge

55. Which sentence uses the word "<u>valid</u>" correctly?

a) He did not know the true valid of the house
b) By his brave actions, the man showed himself to be valid
c) Poverty meant that his house became valid
d) The point made by the politician was valid

NON-TECHNICAL VOCABULARY TEST (GREEN)

Directions: Read the questions carefully and circle the correct answer. Please do not skip any question.

Note: There is only one correct answer.

1. The exam grade was a percentage. This means it was

    a) Given to all students
    b) A large number
    c) The average of the class
    d) Out of hundred

2. Which sentence uses the word excite correctly?

    a) Just the thought of the party began to excite him
    b) Dogs should not be allowed to excite on sidewalks
    c) The freshly made tea was left to excite to improve its flavor
    d) The girl began to excite a page from her book

3. The builder is a capable work-man. This means he

    a) Never leaves a mess
    b) Works very hard
    c) Can do his job
    d) Always takes his time

4. Which sentence uses the word repel correctly?

    a) "Repel these bad laws" shouted the crowd
    b) The defenders managed to repel the attackers
    c) To repel the bicycle was the only way to make it work
    d) It was such an enjoyable sweet that I felt repel to have another

5. The rainfall was average for May. This means it was

    a) The highest ever for May
    b) About normal for May
    c) The lowest ever for May
    d) Higher than any other month

6. Appropriate can mean

    a) Suitable
    b) Unfit
    c) Opposite
    d) Improper

7. The flower had a characteristic smell. This means that the smell was

   a) Strong
   b) Unlike any other smell
   c) Invisible
   d) Nice

8. Which sentence uses the word "classify" correctly?

   a) Classify the dishes with soap and water
   b) Classify the argument by expanding the main point
   c) Classify the rocks according to their age
   d) Classify the crystals together

9. The word "component" means

   a) Part of the whole
   b) All of the units
   c) Compound
   d) Original

10. The word "contrast" means

   a) To compare so as to point out differences
   b) To make or become smaller
   c) To grasp by understanding
   d) To plan what to do

11. The word "device" means

   a) appliance
   b) solution
   c) opportunity
   d) chance

12. The doctor was able to diagnose the man's illness. This means that the doctor

   a) Gave him some medication
   b) Said what the illness was
   c) Made him better
   d) Referred him to a specialist

13. The word "diversity" means

a) Variety
b) Opposition
c) Shortage
d) Similarity

14. Putting the car brakes on had no effect. This means the car

a) Stopped
b) Did not stop
c) Went faster
d) Turned around

15. Which sentence uses the word emit correctly?

a) The girl would never emit that the book was here
b) A heavy black coat will emit light on a sunny day
c) A vibrating violin string will emit sound
d) The students were instructed to emit the first four questions in the exercise

16. The student was able to estimate the weight of chemical necessary for the reaction. This means he

a) Measured the weight carefully
b) Used more chemical than what was needed
c) Had done an experiment to find the weight
d) Made a rough guess at the weight

17. The word "exert" means

a) Use
b) Expect
c) Urge
d) Measure

18. The external TV part was placed on the roof. This means the part was

a) Ever lasting
b) Outside
c) High
d) For color reception

19. They described him as the <u>agent</u> of change in government. This means he

a) Stopped the change
b) Brought about the change
c) Opposed the change
d) Was changed by the government

20. If a chemical reaction is described as <u>complex</u>, this means it

a) Goes to completion
b) Forms a compound
c) Is simple
d) Is complicated

21. The children talked about the <u>composition</u> of brick. This means they talked about

a) Its length, width and height
b) What it was made of
c) How it was made
d) What it could be used for

22. The word "<u>concept</u>" means

a) Idea
b) Device
c) Issue
d) Plan

23. The word "<u>contribute</u>" means

a) Give
b) Plan
c) Gather
d) Take

24. The officers discussed how the soldiers would <u>converge</u> on the town. This means they discussed how the soldiers would

a) Tour the town
b) Move near the town
c) Live in the town
d) Advance from the town

25. The word "<u>detect</u>" means

a) Discover
b) Detain
c) Keep in
d) Make up

26. The hairdresser tried to <u>devise</u> a suitable hairstyle for her. This means the hairdresser tried to

a) Describe
b) Think out
c) Make
d) Retain

27. Which sentence uses the word <u>disperse</u> correctly?

a) The magician made the rabbit disperse
b) The old railway line fell into disperse
c) The crowd was able to disperse after the football match
d) The class was asked to disperse the result of the exam

28. Which sentence uses the word <u>efficient</u> correctly?

a) Children need to eat efficient food to grow strong and healthy
b) The sick boy did not eat the fresh fruit and vegetables and was efficient in vitamins as a result
c) Large brooms are more efficient than small brooms for sweeping the school yard
d) The boy did not have efficient qualifications for the job

29. In the experiment, it is <u>essential</u> to heat the ice to get it to melt. This means it is

a) advisable
b) usual
c) customary
d) necessary

30. The girl used <u>excess</u> jam on her sandwich. This means she put on

a) Just the right amount
b) Too much
c) The very best
d) Very little

31. Rainfall is a major factor in the growth of crops. This means it is

a) An event
b) An influence
c) A system
d) An accomplishment

32. Which sentence uses the word "generate" correctly?

a) The police only had a generate description of a criminal
b) Valentine's day is to generate the importance of love
c) To make the old train move it was necessary to generate steam
d) He gave freely of him time and was described as generate

33. The demonstration was designed to illustrate the uses of copper. This means that

a) There were pictures of copper
b) The importance of copper was stressed
c) The uses of copper were related to cost
d) The uses of copper were made clear

34. The word "impact" means

a) Collision
b) Solid
c) Pressure
d) damage

35. The old editor had considerable influence on the young journalist. This means that the editor had

a) An interest in the journalist
b) Power over the journalist
c) Gathered facts for the journalist
d) More experience than the journalist

36. Which sentence uses the word "initial" correctly?

a) The mystery was not solved until the initial chapter
b) The change of plan proved to be initial in winning the match
c) The initial price was 10 $ but it was changed to 5 $
d) The winning goal was won just before the initial goal

37. The art teacher asked the girl to interpret her painting for the class. This means the girl had to

a) Finish the painting
b) Explain what the painting meant
c) Hang the painting on the wall
d) Stop painting and do it again

38. The word "limit" means

a) Restrict
b) Detach
c) Free
d) Open

39. The car's movement was linear. This means the car

a) Kept stopping and starting
b) Moved in a straight line
c) Was dangerous
d) Moved from side to side

40. The scientist was able to identify the problems in the experiment by logic. This means that the scientist

a) Repeated the experiment correctly
b) Made a guess at what had gone wrong
c) Solved the problem by doing another experiment
d) Reasoned out the problems in the method

41. When asked to go to the party her answer was negative. This means

a) Yes
b) No
c) Maybe
d) With one condition

42. He felt his team had the best probability of winning the cup. This means the best

a) Possibility
b) Likelihood
c) Experience
d) Condition

43. Which sentence uses the word "rate" correctly?

a) The climber found the rate atmosphere of the mountain tops very refreshing
b) The invading army decided to rate the village to the ground
c) The car wash launch took off at a great rate
d) It is illegal to discriminate against people because of their religion or their rate

44. During the lesson, the teacher asked the class to make reference to the results of an experiment. This means the teacher asked them to

a) Do the experiment again
b) Learn the results of the experiment
c) Copy down the results of the experiment
d) Look up the results of the experiment

45. The word "relative" means

a) Implying a comparison
b) Getting smaller
c) Positively accurate
d) Falling back

46. The word "relevant" means

a) Concerned with
b) Attached to
c) Divided into
d) Distinguished from

47. Which sentence uses the word "sequence" correctly?

a) The author was going to write a sequence to her novel
b) The dancer had many sequence on her dress
c) 1,2,3,4 is a different sequence from 4, 3,2,1
d) His behavior was rarely sequence and he was often punished

48. The scientists knew the source of the chemical. This means they knew

a) Its properties
b) How to dispose of it
c) Its cost
d) Where it came from

49. The word "standard" means

a) The thing by which the qualities of something may be tested
b) The position or point of view from which a matter is considered
c) Established reputation
d) Similar position

50. The word "stimulate" means

a) Spark to action
b) State terms
c) Put an end to
d) Slow down

51. When using the knitting patterns, she would substitute nylon for wool. This means she would

a) Use either nylon or wool
b) Use nylon instead of wool
c) Strengthen the wool with nylon
d) Add nylon with wool

52. The game was to pick a symmetrical object from the table. This means you had to pick a thing that

a) Was the odd one out
b) Able to divide it into equal parts
c) Was the same as the others
d) Was made of plastic

53. Which sentence uses the word "system" correctly?

a) He had to replace his system when his water tank leaked
b) The prisoner was able to escape through a system in the fence
c) Roads are an important part of the country's transport system
d) The sailor used his compass to set a system for home

54. A scientific theory means

a) A set of instructions for doing an experiment
b) A set of symbols and rules
c) A collection of facts that are gained from experiments
d) A collection of ideas that are used to explain certain facts

55. The teacher felt that the student's explanation of the results was valid. This means the teacher felt it was

a) Worthless
b) Not correct
c) Brief
d) Correct

NON-TECHNICAL VOCABULARY TEST (YELLOW)

Directions: Read the questions carefully and circle the correct answer. Please do not skip any question.

Note: There is only one correct answer.

1. The exam grade was a percentage. This means it was
   a) Given to all students
   b) A large number
   c) The average of the class
   d) Out of hundred

2. Which sentence uses the word excite correctly?
   a) Just the thought of the party began to excite him
   b) Dogs should not be allowed to excite on sidewalks
   c) The freshly made tea was left to excite to improve its flavor
   d) The girl began to excite a page from her book

3. The builder is a capable work-man. This means he
   a) Never leaves a mess
   b) Works very hard
   c) Can do his job
   d) Always takes his time

4. Which sentence uses the word repel correctly?
   a) "Repel these bad laws" shouted the crowd
   b) The defenders managed to repel the attackers
   c) To repel the bicycle was the only way to make it work
   d) It was such an enjoyable sweet that I felt repel to have another

5. The rainfall was average for May. This means it was
   a) The highest ever for May
   b) About normal for May
   c) The lowest ever for May
   d) Higher than any other month

6. Which sentence uses the word "<u>appropriate</u>" correctly?

   a) A raincoat is an appropriate clothing for a wet day
   b) The appropriate height of Burj Khalifa is 0.8 Km
   c) The appropriate machinery in the old factory was useless
   d) The black fly was appropriate in the clean white sheet

7. When an animal has a <u>characteristic</u> behavior, this means the behavior is

   a) Unexpected
   b) Typical
   c) Fast
   d) Slow

8. The word "<u>classify</u>" means

   a) Make clear
   b) Qualify
   c) Place in similar groups
   d) Separate

9. Which sentence uses the word <u>component</u> correctly?

   a) The chicken was a component of the soup
   b) Adam was Samir's component in the fight
   c) The student was not component to drive the car
   d) The girl was component that she would pass the test

10. Which sentence uses the word "<u>contrast</u>" correctly?

   a) The painter used the black next to the white as a contrast
   b) The contrast lines on the map show where the hills are
   c) Many short stories were contrasted to make the book
   d) As the metal cooled rapidly it was seen to contrast

11. Which sentence uses the word "<u>device</u>" correctly?

   a) A hammer is a device which is used to knock in nails
   b) Leather is a device which is used to make shoes
   c) An egg is a device from which chickens come out
   d) The builder examined the detailed device, which the architect had drawn to show the plan of the house

12. The scientist was not able to <u>diagnose</u> the mistake in her experiment. This means she was not able to

    a) Correct the mistake
    b) Say what the mistake is
    c) Skip the mistake
    d) Remove the mistake

13. Which sentence uses the word "diversity" correctly?

    a) The diversity of the plants made the old man happy
    b) The smart student hoped to go to diversity
    c) After the road accident, the police organized a diversity
    d) The diversity of the swimmer took her to the bottom of the pool

14. If you were asked to find the <u>effect</u> of adding acid to a metal, this means you would try to find

    a) The reason for adding the acid
    b) What happened
    c) How the long the reaction took
    d) The amount of acid used

15. The word "<u>emit</u>" means

    a) Take in
    b) Move from
    c) Give out
    d) Put on

16. He <u>estimated</u> he needed four buckets of paint to finish the whole room. This means he

    a) Had accurately measured it
    b) Had allowed a lot more than what he needed
    c) Had precisely measured it
    d) Approximately judged

17. Which sentence uses the word "<u>exert</u>" correctly?

    a) When you climb the stairs you exert yourself
    b) It is felt that dinosaurs no longer exert
    c) By living abroad the actor hoped to be exert from paying taxes
    d) At the end of the scene the actor had to exert the stage

18. Some animals have an <u>external</u> skeleton. This means their skeleton is

a) Hard
b) Outside
c) Inside
d) Soft

19. The chemical was described as the <u>agent</u> of change in the reaction. This means the chemical

a) Stopped the change
b) Brought about the change
c) Opposed the change
d) Was changed by the reaction

20. The television is a <u>complex</u> piece of equipment. This means it is

a) Cleverly thought out
b) Very useful
c) Capable of breaking
d) Made of many parts

21. The purpose of the experiment was to find the <u>composition</u> of the mixture. This means that the purpose was to find

a) The total weight
b) What it was made of
c) How it was made
d) What it could be used for

22. Which sentence uses the word "<u>concept</u>" correctly?

a) The concept was difficult to grasp because he had not been listening to the teacher
b) Up to the final whistle, he would not concept that his team were losing
c) People avoided her because she seemed wise in her own concept
d) The musician in the year's concept performed well

23. Which sentence uses the word "<u>contribute</u>" correctly?

a) She decided to contribute to a local charity
b) At the end the audience stood to contribute him on the performance
c) After the referee spoke to him he did not contribute the rules again
d) He was not able to contribute a way to open the locked door

24. The scientist discussed why the results from the two experiments seemed to <u>converge</u>. This means the results seemed to

a) Go into reverse
b) Move nearer together
c) Move further apart
d) Both change slowly

25. Which sentence uses the word "<u>detect</u>" correctly?

a) The scar on her face was impossible to detect
b) Cameras detect pictures on rolls of films
c) In X ray units, lead screens detect people from radiation
d) A tape measure can be used to detect a person's wait measurement

26. The students were asked to <u>devise</u> an experiment. This means they had to

a) Write about the results of the experiment
b) Think how they would do the experiment
c) Make measurements during the experiment
d) Do the experiment

27. The word "<u>disperse</u>" means

a) Prepare
b) Collect
c) Scatter
d) Reduce

28. The word "<u>efficient</u>" means

a) Unable
b) Flowing
c) Able
d) Producing

29. It is <u>essential</u> to wear eye safety goggles when welding. This means it is

a) Optional
b) Legal
c) Not needed
d) Necessary

30. During the experiment, the teacher required the students to have the chemical in excess. This means the students would have to

a) Make sure all chemicals were used up
b) Make sure some chemicals are left
c) Put the chemicals in a special container
d) Add water to the chemicals

31. The outcome of the complex chemical reaction depended on many factors. This means it depended on

a) Events
b) Influences
c) Systems
d) Accomplishments

32. The word "generate" means

a) Destroy
b) Examine
c) Make
d) Reduce

33. This chapter will illustrate the points made in the last chapter. This means it will

a) Gloss over the points
b) Contain more photographs
c) Leave out the points
d) Make the points clearer

34. Which sentence uses the word "impact" correctly?

a) The impact of the cars caused both of them a lot of damage
b) A box of matches is small and impact
c) Brass is an impact of copper and zinc
d) The earth moves around the sun in an impact that takes one year

35. Temperature has an influence on the speed of the chemical reaction. This means the temperature

a) Increases it
b) Affects it
c) Slows it down
d) Stops it

36. The word "initial" means

a) Final
b) Within
c) Beginning
d) Ending

37. The student was able to interpret the results of his experiment. This means he was able to

a) Find a mistake and correct it
b) Explain the meaning of the results
c) Write the results in his notebook
d) Do more experiments to confirm the results

38. Which of these sentences uses the word "limit" correctly?

a) The speed limit in some parts of Beirut is 40 miles per hour
b) He used the pieces of cord and pin as his finishing limit
c) The child's behavior made his parents absolutely limit
d) Her collection of seashells was improved by finding the limit on the rock

39. The growth of the cells was linear. This means the growth was

a) Constant
b) Changing
c) Horizontal
d) Varying

40. The mathematical puzzle could only be solved by the use of logic. This means by the use of

a) A computer
b) A calculator
c) Tables
d) Reasoning

41. The temperature of the substance was negative. This means the temperature of the substance was

a) Between 0 °C and 25 °C
b) Less than 0 °C
c) More than 25 °C
d) Not able to be measured

42. When students read the instructions for the experiment, he thought there was some probability of success. This means the student thought that

a) There were some problems
b) There were some chance of success
c) The instructions were difficult
d) There was no chance of completing the experiment

43. The word "rate" means

a) Structure
b) Size
c) Speed
d) Symbol

44. The letter contained a reference to the king. This means the letter

a) Apologized to the king
b) Was sent to the king for his attention
c) Requested the king to do something
d) Mentioned something the king had done

45. Which sentence uses the word "relative" correctly?

a) Relative to concrete, steel is a harder material
b) A light bulb is a relative of electricity
c) The poor answer was no relative to the question
d) Copper is a relative metal because it can be beaten out

46. Which sentence uses the word "relevant" correctly?

a) The weather conditions were relevant to the cause of the accident
b) Economists think that supply is relevant to demand
c) She is beautiful to me but beauty is relevant to the beholder's eye
d) His boss described him as relevant because the boss could always depend on him

47. The word "sequence" means

a) Random units
b) What follows after
c) Unbroken series
d) What came before

48. The explorers knew the source of the river. This means they knew

a) Its length
b) Where it went to
c) It's worth
d) Where it began

49. Which sentence uses the word "standard" correctly?

a) All the students who passed the exam had reached the required standard
b) The distance round a circle is called the standard
c) No amount of discussion could persuade him to change his standard on the advantages of yoga
d) The water in the pool was standard

50. Which sentence uses the word "stimulate" correctly?

a) The sharp taste of food was able to stimulate her taste buds on her tongue
b) The bandage was able to stimulate the flow of blood from the wound
c) The winter weather was able to stimulate throat infection
d) The sculpture was able to stimulate clay into useful pots

51. During her experiment, the scientist decided to substitute aluminum for iron. This means she would

e) Use either aluminum or iron
a) Use aluminum for instead of iron
b) Strengthen the iron with aluminum
c) Increase the density of the aluminum with iron

52. The scientist's experiment was to find the age at which children could pick a symmetrical thing from a tray filled with different objects. This means the child had to pick a thing that

a) Was the odd one out
b) Was able to be divided into equal parts
c) Was the same as another object
d) Was man-made rather than natural

53. The word "system" means

e) Group of unclear ideas
a) Total
b) Set of connected things
c) Patterns

54. The police had a theory for the crime. This means they had

e) A fact
f) A procedure
a) A system
b) A view held

55. The man felt that the point made by the politician was valid. This means he felt that it was

a) Worthless
b) A lie
c) True
d) Correct

APPENDIX III

LIST OF FREQUENTLY ENCOUNTERED NON-TECHNICAL TERMS IN THE SCIENCE FUSION TEXTBOOKS

1. Agent
2. Appropriate
3. Characteristic
4. Classify
5. Complex
6. Components
7. Composition
8. Concept
9. Contrast
10. Contribute
11. Converge
12. Device
13. Diagnosed
14. Diversity
15. Detect
16. Devise
17. Dispersed
18. Effect
19. Efficient
20. Emit
21. Essential
22. Estimate
23. Excess
24. Exert
25. External
26. Factor
27. Generate
28. Illustrate
29. Impact
30. Influence
31. Initial
32. Interpret
33. Limit
34. Linear
35. Logic
36. Negative
37. Probability
38. Rate
39. Reference
40. Relative
41. Relevant
42. Sequence
43. Source
44. Standard
45. Stimulate
46. Substitute
47. Symmetrical
48. System
49. Theory
50. valid

APPENDIX IV

INTERVIEW QUESTIONS

For each problematic non-technical term, the following questions were asked:

1. What is the meaning of this word?
2. What is the difference between this word and another one (use of look-alike, sound-alike word or word with opposite meaning)
3. Use this word in a sentence.

APPENDIX V

WORD BY WORD ANALYSIS

The following presents a word by word analysis of the 30 problematic non-technical terms. Terms were labeled as satisfactory in a given context if students obtained more than 50% of correct responses. Students' performances on the remaining 20 terms were satisfactory (more than 50% correct responses across four contexts). These terms were therefore not included in this analysis.

Agent

- Generally satisfactory except for synonym context (46.2%)
- Nonscientific and scientific: confused with being the receiver of change (opposite meaning)
- Every day: confused with accent (look alike/sound alike word)
- Synonym: mixed with promoting recovery (imprecise meaning)

Classify

- Generally weak especially in the science context (19.6%). Highest score achieved in the non-science context (82.1%)
- Nonscientific: confused with counting (imprecise meaning)
- Every day and synonym : confused with explain, clarify, make clear (imprecise meaning)
- Scientific: confused with identify, indicate (imprecise meaning)

Converge

- Generally weak except for non-scientific (51.2%)
- Nonscientific: confused with moving around an area (imprecise meaning)
- Every day: confused with converse (look alike/sound alike word)
- Scientific: confused with changing slowly
- Synonym: confused with change

Device

- Satisfactory except for the everyday context (38.5%)
- Nonscientific: confused with inventory (imprecise meaning)
- Every day: mixed with design (look alike/sound alike word)
- Scientific: confused with method (imprecise meaning)
- Synonym: confused with opportunity and chance (imprecise meaning)

Devise

- Very weak for all contexts
- Nonscientific: confused with make, do (imprecise)
- Every day: confused with despise (look alike/sound alike word)
- Scientific: confused with make, do (imprecise)
- Synonym: confused with keep in

Diagnose

- Weak except for non-science (67.4%) and science (51.3%)
- Nonscientific: confused with treat (imprecise meaning)
- Every day: confused with measure (imprecise meaning)
- Scientific: confused with correcting (imprecise meaning)
- Synonym: confused with infer, interpret (imprecise meaning)

Disperse

- Very weak for all contexts
- Nonscientific: confused with caused no trouble
- Every day: confused with disuse (look alike/sound alike word)
- Scientific: confused with bright
- Synonym: confused with collect, bring together (opposite meaning)

Emit

- Very weak in all contexts except for non-science (66.7%)
- Nonscientific: confused with reflect (imprecise meaning)
- Every day: mixed with admit (look alike/sound alike word) and absorb (opposite meaning)
- Scientific: confused with transfer (imprecise meaning)Synonym: mixed with taking in, absorbing (opposite meaning)

Efficient

- Weak for all contexts except for synonym (56%)
- Nonscientific: confused with most commonly used. Guessing pattern in two distractors
- Every day: confused with sufficient (look alike/sound alike word). Guessing pattern in two distractors
- Scientific: confused with easy
- Synonym: confused with produce, manufacture. Guessing pattern evident in two distractors

Estimate

- Satisfactory for scientific (65.1%) and non-scientific (69.2%)
- Very weak for every day and synonym: confused with calculate, accurate measurement (opposite meaning)

Excess

- Weak in all contexts except for non-scientific (67.4%)
- Nonscientific: satisfactory. Guess pattern evident
- Every day: confused with excellent (look alike/sound alike word)
- Scientific: confused with deficit/not having enough of something (opposite meaning)
- Synonym: confused with except (look alike/sound alike word)

Exert

- Very weak for all contexts except for science (79.5%).
- Nonscientific: confused with raise up (imprecise meaning)
- Every day: confused with exempt (look alike/sound alike word)
- Scientific: satisfactory, guessing pattern evident in two distractors
- Synonym: confused with urge (look alike/sound alike word)

Factor

- Weak in all contexts except for non-scientific (55.8%)
- Nonscientific: confused with event (imprecise meaning)
- Every day: confused with fraction and favor (look alike/sound alike words)
- Scientific: confused with system
- Synonym: confused with structure

Impact

- Weak except for scientific (56.4%) and everyday (61.5) contexts
- Nonscientific: confused with product
- Every day: satisfactory. Guessing pattern evident
- Scientific: confused with explosion (imprecise meaning)
- Synonym: confused with damage (imprecise meaning)

Influence

- Weakest in two contexts with highest scores in synonym (69.2%) and science (71.9%)
- Nonscientific: confused with having interest in
- Every day: confused with instance (look alike/sound alike word)
- Scientific: confused with slow down
- Synonym: satisfactory. Guessing pattern evident

Initial

- Very weak throughout except for everyday context (65.1%)
- Nonscientific: confused with most important
- Every day: confused with essential (sound alike word) also with final (opposite meaning). Guessing pattern evident.
- Scientific: confused with careful
- Synonym: confused with final (opposite meaning)

Linear

- Weak in two contexts. Highest score achieved in synonym (69.2%) and non-scientific contexts (55.8%)
- Nonscientific: guessing pattern
- Every day: confused for speedometer
- Scientific: confused with horizontal (imprecise meaning)
- Synonym: confused with increasing (imprecise meaning), guessing pattern evident

Probability

- Very weak especially for synonym context (12.8%). Highest score achieved in science context 64.1%
- Nonscientific: confused with possibility (imprecise meaning)
- Every day: confused with probation and liability (look alike/sound alike word). Guessing pattern evident in two distractors
- Scientific: guessing pattern in two distractors
- Synonym: confused with possibility (imprecise meaning)

Rate

- Very weak in 3 contexts especially scientific (28.3%). Highest score achieved in non-scientific context (56.4%)
- Nonscientific: confused with wasting of something and noise produced. Guessing pattern
- Every day: confused with rare (look alike/sound alike word). Guessing pattern evident in two distractors
- Scientific: confused with effect and result. Guessing pattern evident.
- Synonym: confused with structure. Guessing pattern evident

Reference

- Very weak especially for everyday context (17.9%). Highest score achieved for non-science context (53.8%)
- Nonscientific: confused with apologizing and act of doing something. Guessing pattern evident in two distractors
- Every day: confused with looking at something for information (imprecise meaning)

- Scientific: confused with copying down
- Synonym: confused with reasoning (look alike/sound alike word)

Relative

- Very weak especially with the everyday context (33.5%). Highest score achieved with the non-science context (52.8%)
- Nonscientific: confused with similar to, same as (imprecise meaning). Guessing pattern evident in two distractors
- Every day: confused with relevant (look alike/sound alike word)
- Scientific: confused with relevant (look alike/sound alike word)
- Synonym: confused with positively accurate (imprecise meaning)

Relevant

- Weak throughout except for synonym context (51.2%)
- Nonscientific: confused with not related to (opposite meaning) guessing pattern evident.
- Every day: confused with relative (look alike/sound alike word)
- Scientific: confused with caused (imprecise meaning)
- Synonym: confused with attached (imprecise meaning)

Sequence

- Weak in two contexts (science and synonym). Highest score achieved in non-science context (61.5%)
- Nonscientific: satisfactory. Guessing pattern evident in two distractors
- Every day: satisfactory. Confused with sequel (look alike/sound alike word)
- Scientific: confused with quality, standard
- Synonym: confused with what follows after, come next (imprecise meaning)

Source

- Satisfactory for all contexts except for everyday context (25.6%)
- Nonscientific: confused with worth, value
- Every day: confused with sauce (look alike/sound alike word)
- Scientific: confused with property, characteristic
- Synonym: confused with product

Standard

- Very weak in all contexts except for everyday context (59%)
- Nonscientific: confused with not ready to be used , not prepared
- Every day: confused with stance (look alike word)
- Scientific: confused with not ready to be used
- Synonym: confused with point of view

Stimulate

- Very weak in all contexts except for science context (56.4%)
- Nonscientific: confused with block (opposite meaning) guessing pattern evident in two distractors
- Every day: confused with block, stop (opposite meaning)
- Scientific: confused with deactivate (opposite meaning)
- Synonym: confused with state or declare (look alike word) and with stopping an event (opposite meaning). Guessing pattern evident

Symmetrical

- Very weak in all contexts except for synonym (61.5%)
- Nonscientific: confused with being odd or different and having the same shape as others (imprecise meaning). Guessing pattern evident.
- Every day: confused with simmer (look alike/sound alike word). Guessing pattern evident for two distractors
- Scientific: confused with an object having a different shape (imprecise meaning)
- Synonym: confused with having a special shape (imprecise meaning)

System

- Weak for two contexts (science and non-science). Highest score achieved in synonym context (64.1%)
- Nonscientific and every day: confused with one part of a whole (imprecise meaning)
- Scientific: confused with thinking
- Synonym: confused with total, whole (imprecise meaning)

Theory

- Very weak in all contexts except for synonym (50%)
- All contexts : confused with fact

Valid

- Very weak especially in non-science context (17.9%). Highest score achieved in science context (53.5%)
- Nonscientific: confused with true (imprecise meaning)
- Every day: confused with valorous (look alike/sound alike word)
- Scientific: confused with incorrect (opposite meaning)
- Synonym: confused with worthy

APPENDIX VI

PERCENTAGES OF CORRECT RESPONSES PER CONTEXT FOR EACH GRADE

Table 15

Percentage of correct responses per context in grade 6

Non-technical term	Synonym	Everyday	Science	Non-science
Classify	50.00	50.00	0.00	87.50
Device	87.50	16.67	50.00	55.56
Diagnose	25.00	11.11	50.00	87.50
Emit	16.67	25.00	11.11	62.50
Estimate	11.11	50.00	75.00	50.00
Exert	37.50	50.00	62.50	44.44
Agent	37.50	22.22	33.33	12.50
Converge	12.50	33.33	33.33	62.50
Devise	0.00	11.11	16.67	37.50
Disperse	0.00	62.50	33.33	37.50
Efficient	66.67	50.00	44.44	50.00
Excess	25.00	33.33	66.67	75.00
Factors	37.50	55.56	0.00	62.50
Impact	12.50	66.67	62.50	44.44
Influence	87.50	22.22	66.67	12.50
Initial	0.00	75.00	22.22	12.50
Linear	87.50	22.22	50.00	50.00
Probability	0.00	33.33	66.67	12.50
Rate	50.00	50.00	55.56	37.50
Reference	33.33	12.50	62.50	50.00
Relative	50.00	66.67	25.00	66.67
Relevant	25.00	50.00	50.00	44.44
Sequence	0.00	62.50	55.56	62.50
Source	44.44	25.00	37.50	66.67
Standard	0.00	83.33	25.00	33.33
Stimulate	37.50	16.67	62.50	44.44
Symmetrical	75.00	33.33	33.33	37.50
System	50.00	62.50	44.44	50.00
Theory	44.44	37.50	0.00	33.33
Valid	11.11	37.50	37.50	0.00

Table 16

Percentage of correct responses per context in grade 7

Non-technical term	Synonym	Everyday	Science	Non-science
Classify	40.00	58.33	8.33	70.00
Device	58.33	40.00	30.00	33.33
Diagnose	20.00	58.33	40.00	66.67
Emit	30.00	16.67	41.67	50.00
Estimate	25.00	30.00	75.00	60.00
Exert	41.67	50.00	90.00	25.00
Agent	60.00	50.00	40.00	58.33
Converge	10.00	16.67	30.00	33.33
Devise	40.00	25.00	70.00	16.67
Disperse	70.00	33.33	41.67	30.00
Efficient	40.00	41.67	33.33	30.00
Excess	40.00	41.67	20.00	75.00
Factors	30.00	41.67	50.00	58.33
Impact	33.33	70.00	60.00	25.00
Influence	60.00	33.33	40.00	33.33
Initial	70.00	66.67	33.33	40.00
Linear	70.00	25.00	40.00	50.00
Probability	0.00	33.33	40.00	8.33
Rate	60.00	41.67	33.33	50.00
Reference	58.33	20.00	33.33	40.00
Relative	50.00	50.00	40.00	50.00
Relevant	50.00	20.00	60.00	33.33
Sequence	40.00	58.33	41.67	60.00
Source	41.67	20.00	58.33	70.00
Standard	16.67	70.00	30.00	58.33
Stimulate	16.67	20.00	40.00	25.00
Symmetrical	40.00	25.00	30.00	33.33
System	60.00	50.00	16.67	50.00
Theory	50.00	50.00	25.00	30.00
Valid	58.33	40.00	41.67	10.00

Table 17
Percentage of correct responses per context in grade 8

Non-technical term	Synonym	Everyday	Science	Non-science
Classify	16.67	60.00	18.18	77.78
Device	50.00	50.00	33.33	45.45
Diagnose	11.11	54.55	33.33	70.00
Emit	58.33	20.00	36.36	77.78
Estimate	36.36	44.44	50.00	75.00
Exert	20.00	16.67	77.78	27.27
Agent	33.33	54.55	58.33	50.00
Converge	33.33	36.36	50.00	70.00
Devise	44.44	18.18	41.67	20.00
Disperse	33.33	30.00	45.45	55.56
Efficient	58.33	60.00	45.45	33.33
Excess	44.44	36.36	33.33	50.00
Factors	22.22	45.45	33.33	40.00
Impact	30.00	41.67	44.44	45.45
Influence	55.56	18.18	75.00	10.00
Initial	33.33	50.00	36.36	11.11
Linear	66.67	27.27	33.33	40.00
Probability	11.11	36.36	66.67	10.00
Rate	33.33	40.00	45.45	77.78
Reference	45.45	22.22	20.00	58.33
Relative	30.00	33.33	22.22	54.55
Relevant	50.00	58.33	55.56	27.27
Sequence	16.67	50.00	36.36	55.56
Source	54.55	22.22	50.00	50.00
Standard	30.00	25.00	55.56	54.55
Stimulate	40.00	41.67	55.56	36.36
Symmetrical	66.67	27.27	41.67	40.00
System	83.33	30.00	54.55	22.22
Theory	54.55	44.44	40.00	33.33
Valid	27.27	22.22	50.00	33.33

Table 18
Percentage of correct responses per context in grade 9

Non-technical term	Synonym	Everyday	Science	Non-science
Classify	40.00	69.23	42.86	91.67
Device	53.85	40.00	75.00	64.29
Diagnose	16.67	21.43	90.00	53.85
Emit	50.00	69.23	35.71	75.00
Estimate	7.14	33.33	61.54	70.00
Exert	30.77	50.00	83.33	42.86
Agent	50.00	64.29	70.00	69.23
Converge	50.00	21.43	90.00	46.15
Devise	58.33	35.71	40.00	53.85
Disperse	40.00	23.08	42.86	58.33
Efficient	50.00	46.15	35.71	50.00
Excess	66.67	50.00	50.00	69.23
Factors	25.00	35.71	30.00	69.23
Impact	23.08	70.00	58.33	57.14
Influence	75.00	57.14	80.00	53.85
Initial	70.00	69.23	64.29	50.00
Linear	58.33	50.00	20.00	69.23
Probability	33.33	57.14	70.00	30.77
Rate	30.00	53.85	7.14	58.33
Reference	35.71	16.67	30.77	60.00
Relative	38.46	10.00	50.00	42.86
Relevant	69.23	70.00	25.00	14.29
Sequence	30.00	61.54	42.86	66.67
Source	42.86	33.33	61.54	60.00
Standard	15.38	80.00	41.67	35.71
Stimulate	53.85	40.00	66.67	28.57
Symmetrical	66.67	64.29	40.00	23.08
System	40.00	69.23	50.00	25.00
Theory	28.57	33.33	30.77	60.00
Valid	14.29	66.67	76.92	30.00