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Analysis of Nominalization in Elementary and Middle School Science Textbooks

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ANALYSIS OF NOMINALIZATION IN ELEMENTARY AND MIDDLE SCHOOL SCIENCE TEXTBOOKS

By

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To my daughters, Petra and Torah, who are only in the beginning stages of their education and language development. May you develop a love for learning and an appreciation of the written word.

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CHAPTER ONE: INTRODUCTION

Nominalization in Science Texts

"*For many pupils the greatest obstacle in learning science---and also the most important achievement---is to learn its language*" (Wellington & Osborne, 2001, p. 3).

Many elementary and middle school students, especially English Learners (ELs), feel overwhelmed while attempting to access information in science texts (Fang, 2004). Recent studies have focused on the features and linguistic challenges of science reading. One such grammatical feature, nominalization, has been investigated by many researchers over the years including Derewianka (1990) and Fang (2004). Nominalization describes the derivation of a noun from another kind of grammatical element (Matthews, 2014). Typically this is evidenced through a verb transforming into a noun. For example, in the following sentence, the underlined nominalization, *diffusion*, is a noun used to describe a process instead of the verbal structure, *diffuse*, "Materials can move through the membrane by diffusion or osmosis." A number of nominalization types will be discussed in further detail in Chapter Two including a) nouns and verbs spelled alike, b) gerunds, c) verbs to nouns, and d) adjectives to nouns. Nominalizations in elementary and middle school science textbooks will be analyzed throughout this research to determine how nominalizations might contribute to text complexity.

Previous research has noted the complexity of academic texts and the unique qualities that each text genre contains (Schleppegrell, 2001). Text complexity is multi-faceted subject with more than one definition. Although text complexity includes many components including clausal, phrasal, lexical, and sentence level complexity, due to the scope of this study, only noun phrase complexity will be considered. Jackendoff defines noun phrases as "syntactic phrases that consist of an obligatory head plus optional modifiers" (as cited in Ravid & Berman, 2010, p. 5). These modifiers can include determiners (*the rocks*), prepositional phrases (*rocks under the surface*), demonstratives (*this rock*), adjectives or adjectival phrases (*metamorphic rocks*), quantifiers (*many* rocks), and relative clauses (*rocks that have undergone a metamorphic* change) or combinations of these modifiers. Depending on the researcher, the definition of noun phrase complexity varies. According to Ravid and Berman (2010), it is determined by the number of words in a noun phrase and by the number of noun phrases in a text. Fang et al. (2006) describes complex noun phrases as the use of embedded clauses to expand the noun phrase whereas Biber et al. (2011) states that having more words in noun phrases adds to sentence complexity. Although noun phrase complexity may be measured in many different ways, for the purpose of this research, the increase of words in a noun phrase will make that noun phrase more complex. It should be noted that complexity is a profound concept which is difficult to measure. This research is by no means comprehensive nor conclusive. However, because nominalization is an area that contributes to text complexity (Schleppegrell, 2010; Halliday & Martin, 1996), complexity is a topic that will be explored in this study.

Science texts contain specific text features including technical terminology, lexical density, and abstraction (Fang & Schleppegrell, 2008). Prior research also explains how students, typically language learners, often struggle in school because they lack the ability to access content-specific academic language (Schleppegrell, 2004). Thus, Schleppegrell (2004) states that teachers should identify the grammatical expectations of a language task so that they better understand the challenges that academic texts can pose for students. Abstractions, including nominalizations, are one of the most common science text features and their effect on sentence and noun phrase complexity has been extensively studied by many scholars including Schleppegrell (2010) and Halliday & Martin (1996). Researchers have indicated various types of nominalizations as well. These types include nouns and verbs spelled alike, gerunds (a verb root which receives a morphological –ing ending to change it to a noun form), verbs to nouns (the addition of a suffix to the verb form or a modification of the verb root), and adjectives to nouns (the addition of a suffix to an adjective) (Hartnett, 1998; Humphrey, et al., 2012; Rodby & Winterowd, 2005).

Research has also revealed how nominalization production develops from childhood through adolescence (Derewianka, 2003) and how some children are able to comprehend more metaphorical modes of expression, including nominalizations, beginning at age nine or ten (Halliday & Matthiessen, 2014). Nominalizations have also been considered/analyzed in the framework of Systemic Functional Linguistics (SFL; see Halliday, 1985), also called Systemic Functional Grammar, by Sanders & Sanders (2006), Eggins (2004), and Schleppegrell (2007), among others. This approach explores

how language is used in different contexts and affirms that syntax and meaning come together to create a message.

Although previous research has observed features of scientific text (Fang & Schleppegrell, 2008), investigated how nominalization occurs in scientific texts (Martin, 1991; Kazemian, et al., 2013), and even the age at which nominalization production and comprehension occurs (Derewianka, 2003; Halliday & Matthiessen, 2014), no known studies to date have analyzed the existence and implications of nominalizations in specific grade-level science texts. The current study aims at filling this gap.

Background of the Researcher

I have spent the past eight years working in schools where the majority of the students are ELs. As a mainstream classroom teacher, the majority of my experience was with fourth graders, but more recently, as an EL teacher, I've worked with students from kindergarten through sixth grade. Through my experiences in various elementary and middle schools and through my education in graduate school, a passion has developed to make academic content accessible to non-native English-speaking students. This goal was first tackled through vocabulary instruction, hands-on learning activities, and through increased opportunities for students to verbally process information. But, as I continued to teach, it became apparent that reading comprehension of informational text still eluded a number of my students, especially science text comprehension.

In my experience, students have enjoyed participating in hands-on learning activities in science class and have succeeded in communicating their understanding in oral or written explanations. However, many of my students, especially the ELs, have

appeared frustrated while reading science materials and they have failed to meet the expected targets on standardized tests which require reading and response to written information. Chall, Jacobs, and Baldwin (as citied in Fang, 2006, p. 491-2) mention the dramatic decline of literacy comprehension often referred to as the "fourth grade slump" which occurs once students change from learning to read to reading to learn. Is this 'slump' the cause of the frustration or is there more to the problem?

With a rising emphasis being placed on non-fiction reading (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010), the frustration and failure to achieve proficiency presents a huge challenge. Students are required to show proficiency on many standardized assessments that include informational texts. In Minnesota, it is mandatory for students to complete a science Minnesota Comprehensive Assessment (MCA) in 5th, 8th, and 9-12th grade (Minnesota Department of Education, 2012) and all ELs in kindergarten through twelfth grade need to take a mandatory assessment called Assessing Comprehension and Communication in English State-to-State for English Language Learners (ACCESS for ELLs) every spring (WIDA, 2014). The ACCESS for ELLs includes a section on the language of science. Historically, students, including ELs, have performed worse on the state science tests than on either reading or on math. Data from the Department of Education Minnesota Report Card (Minnesota Department of Education, 2014) for the past few years show that students are performing at a lower proficiency in science on the MCA III than in other tested skills. (Table 1). The results for ELs are even more staggering (Table 2).

Table 1

Minnesota Report Card of Proficient MCA III Results for All Students

Year	Math	Reading	Science
2011	57.8%	N/A	N/A
2012	65.4%	N/A	50.5%
2013	62.6%	57.8%	52.1%
2014	61.4%	59.1%	53.2%

Table 2

Minnesota Report Card of Proficient MCA III Results for ELs

Year	Math	Reading	Science
2011	27.1%	N/A	N/A
2012	32.8%	N/A	10.5%
2013	28.8%	16.0%	11.1%
2014	27.3%	16.4%	9.8%

Multiple aspects may contribute to this deficit. It would be interesting to know what it is about science texts that pose unique challenges to students. If there is something that teachers may be overlooking, I would like to note what is it about upper elementary and middle school texts that seem to be more difficult for students to access.

Development and Purpose of Research

Considering the abovementioned thoughts began a process to clarify the issues underlying sentence and noun phrase complexity in science texts. Fang, Schleppegrell, & Cox (2006) conclude that

> We are often struck by the helplessness and frustration that elementary and secondary students experience when reading and writing academic texts in language arts and other school subjects and classroom instruction typically devotes little attention to the language demands of such texts beyond word recognition, fluency training, vocabulary development, and background knowledge-building activities….Understanding the patterns of language characteristics of different school subjects and genres can enable teachers to better scaffold the development of language and knowledge…Gaining such linguistic insights can help break down the barriers between learner and text and facilitate students' construction of meaning (p. 248-9).

Therefore, because analysis of the linguistic aspects of a text can ultimately help students read academic texts proficiently, the purpose of this research began as an aspiration to understand how specific features affect sentence and noun phrase complexity. Later, since the original observations of students showed that science texts pose an additional challenge, the aim was developed to study the specialized language of science with the hope that a greater focus on the text features could assist students in their comprehension of science texts.

However, as the investigation of science text features ensued, the topic of research advanced to how nominalization affects science sentence and noun phrase complexity. I became increasingly curious about how nominalization changed throughout science curriculum. Consequently, through this study, I seek to understand how nominalization influences the semantic and syntactic complexities that students will inevitably encounter through their scientific studies.

Grammar (morphology and syntax) and meaning (semantics) are intricately related since texts are crafted through the use of grammar and it is grammar that builds meaning in a text (Martin, 1993). The SFL framework provides instruments for analyzing how meaning is affected by the language structures used in a text (Fang & Schleppegrell, 2008) and gives special attention to nominalization (Thompson, 1996). Specifically, emphasis is placed on nominalization through tools that analyze transitivity (Thompson, 1996) and lexical density (Halliday, 1996a) which will be discussed in more detail in Chapter Three. Transitivity focuses on how various processes are structurally arranged (Martin, 2003) by determining if a clause or a word can be classified as an actor, a process, a goal, etc. Lexical density analyzes the number of content words in the text relative to the number of clauses to determine the degree to which a text is packed with information (Halliday, 1996a). Additionally, according to Martin (1993), language study approaches other than SFL struggle to explain the specialized grammar of science which includes abstractions and technicalities. SFL is an approach that explains the syntax of academic writing and how it is used.

Therefore, the purpose of this study is to analyze and compare the occurrence of nominalization in leveled explanation passages from elementary and middle school science textbooks and to determine how nominalization affects the sentence structure and noun phrase complexity. This purpose extends to both content teachers and EL teachers with students that need assistance to access scientific texts. This objective developed partly after reading a previous study of teachers and their understanding of nominalization which concludes that teachers couldn't identify nominalizations in texts nor could they 'de-nominalize' nominalizations (Cameron, 2011). In her thesis, Cameron (2011) says, "for students to effectively use and understand nominalizations, their teachers would first have to recognize the importance and placement of nominalizations" (p. 14). Through the current research, the long-term goal is that this project will further help educators to identify nominalizations and understand how this feature affects sentence and noun phrase complexity. This may ultimately compel teachers to pursue a further understanding of other text features to explicitly teach their students.

Guiding Questions

The issues presented so far have led to the formation of the primary question:

How might nominalization contribute to the sentence structure and noun phrase complexity in first through fifth grade and middle school science textbooks? And the following sub-questions:

- How many examples of nominalization are found in each of the intended levels of texts and what could this indicate?

- Which types of nominalizations are found in each level of science texts and what could this imply?
- How frequently are nominalizations modified by a prepositional phrase that shows agency or force?
- How might nominalization affect the syntax and semantics of the text?
- How might nominalization contribute to lexical density?

Through a series of analyses outlined in Chapter Three, I plan to show at which point nominalizations begin to occur in grade level science passages; to demonstrate how nominalizations complicate texts by illustrating the kinds of nominalizations in texts;, and to identify how the reduced number of clauses in passages with nominalization creates lexical density. The results of this text analysis may highlight how nominalizations behave, how they change in various levels of elementary and middle school science textbooks, and may help readers understand when the need arises to teach nominalization to ELs.

Chapter Overviews

In Chapter One, the topic of the research has been introduced by explaining the background of the researcher as well as the purpose and audience for the study. The first chapter concluded with the guiding questions to be examined in the capstone. In Chapter Two, I will provide a literature review related to science texts, nominalizations, and text analysis along with the perceived gap in previous research. Chapter Three will offer a description of the research design, the methods used to analyze the texts in my study, and how the results will be displayed. Chapter Four will present and evaluate the results from

the text analysis. Finally, Chapter Five will reflect on the collected data, the limitations of the study, and will provide suggestions for further research along with any potential teaching implications.

CHAPTER TWO: LITERATURE REVIEW

The purpose of this study is to analyze and compare the occurrence of nominalization in various levels of elementary and middle school science explanation texts and to determine how nominalization affects the sentence structure and noun phrase complexity of a text. Through an analysis of science texts, I aim to answer the following questions:

How might nominalization contribute to sentence structure and noun phrase complexity in first through fifth grade, and middle school science textbooks?

- How many examples of nominalization are found in each of the intended levels of texts and what could this indicate?
- Which types of nominalizations are found in each level of science texts and what could this imply?
- How frequently are nominalizations modified by a prepositional phrase that shows agency or force?
- How might nominalization affect the syntax and semantics of the text?
- How might nominalization contribute to lexical density?

The following topics will be discussed in this chapter: 1) science texts 2) nominalization, and 3) text analysis. Each topic will be defined and explained to an applicable depth for the scope of this study. The conclusion of this chapter will include a

synopsis of previous studies and the apparent gap in current literature pertaining to nominalization and science.

The Language of Science Texts

Jay Lemke (1990) writes that "the language of science teaching is expository or analytical… used to express relationships of classification, taxonomy, and logical connection among abstract or generalized, terms and processes" (p. 158). Science textbooks, which are crammed with the language of science, are a common teaching tool in classrooms. Students almost certainly will encounter the following four types of writing in a science textbook: a procedure, a procedural recount, a science report or a science explanation (Martin, 1996; Fang, Lamme, & Pringle, 2010; Schleppegrell, 2004). Of all these science genres, science explanations, which give details about how or why a process occurs, most commonly utilize grammatical metaphors to structure the text (Schleppegrell, 2004). Grammatical metaphor is a term related to nominalization meaning substituting an element of one grammatical class for another to express the same or very similar concept (Halliday & Martin, 1996). Typically, language is encoded in a way that suits a particular context. When elements of grammar conform to their characteristic functions, it can be said that they are *congruent* (Christie, 2012). That is, nouns behave as things and entities, and verbs show actions, behaviors, and thought. When language is formatted in a non-congruent manner, it is said to be a *grammatical metaphor*. For example, the verbal element *foliate* can be substituted by the nominal form *foliation*, "Foliation is an arrangement of minerals in flat or wavy parallel bands," (Houghton Mifflin Company, 2005, p. 100). The description *metaphor* is used because

the substituted grammar structure resembles the original form. Since science explanations are the most likely to include grammatical metaphors (Schleppegrell, 2004), I will investigate science explanation passages for occurrences of nominalization.

Use of Science Texts

In 1986, Meyer, Crummey, & Greer stated that science textbooks were the principal mode of science instruction at the elementary level. Today, science textbooks continue to be included in elementary and middle school curriculum decisions and used as a primary teaching tool in the classroom (Holliday, 2004). Science textbooks that are used in schools generally distill information from the greater field of science into major findings of scientific investigations. These books also provide simple instructions to reproduce experiments as well as instructional aids such as chapter reviews or comprehension checks (Stewart-Dore, 1992). Typically, science textbooks come in a series and often build upon each other as the concepts develop throughout the grade levels. They can be used by teachers as an instructional support, used by students as reference tools, or used by learners outside of class to extend their learning (Derewianka, 1992). As will be seen in a later section, the literature of the science profession includes specific terminology and unique features. Even in elementary or middle school science texts, the use of these conventions cannot be avoided (Fang, Lamme, & Pringle, 2010).

Features of Scientific Text

Each academic discipline includes specific types of texts that each have precise linguistic features (Conrad, 1996). The discipline of science involves a specialized

grammar with several characteristic language features that have been extensively studied (Derewianka, 1992; Fang, 2004; 2006; 2008; Fang, Lamme, & Pringle, 2010; Fang and Schleppegrell, 2008; Fang, Schleppegrell & Cox, 2006; Halliday, 1996a; Kazemian, et al., 2013; Schleppegrell, 2001; 2004). It has been argued that science writing relies completely on the language of science and that science texts cannot be written in another manner (Halliday, 1996a; Schleppegrell, 2001).

Although prior studies have focused on multiple characteristics of scientific literacy, due to the scope of this study, only the more basic features will be examined in an overview: technicality, lexical density, authoritativeness, and abstraction. Of these four features, which can typically be interrelated and may influence each other (Fang, 2004), abstraction and lexical density will receive particular attention throughout the study since they are most relevant to the current research of nominalization.

Technical terms are inescapable features of science texts because the field requires specific references to processes or concepts. These terms operate as shorthand versions of more complicated aspects of the discipline and are necessary to express the explicit meaning of a science term to anyone in the field (Derewianka, 1992; Martin, 1996). An example of a technicality would be an adjective (e.g., *respiratory*), verb (e.g., *condense)*, or noun (e.g., *erosion*) that is specific to a certain process or subject of science (Fang, 2004). These science terms often appear in textbooks in bold letters followed by an explanation of the given term or are listed in glossaries and indexes (Fang, 2006). A potentially confusing aspect of technical vocabulary is the use of everyday words in technical settings (Fang, 2006). The word *fault* illustrates this point. A student's

understanding of *fault* in everyday language, meaning *blame,* is much different than the technical definition meaning *a break in a body of rock.* These terms can create comprehension difficulties for students.

Scientific writing features a high level of lexical density signifying that there are a high number content words in the text relative to the number of clauses. Fang (2006), who researched the language demands of science in middle school notes that in order for lexical density to occur, noun phrases lengthen and become more complex to pack more information into each clause. This takes place through the inclusion of pre-modifiers (determiners, adjectives, ordinals) before the noun and post-modifiers (prepositional phrases and embedded clauses) after the noun (Fang & Schleppegrell, 2008). Often, lexically dense sentences have only one or two clauses that are each crammed with meaning (Derewianka, 1990). Michael Halliday's (1996a) format to calculate lexical density measures the number of lexical words (nouns, verbs, adjectives, and some adverbs) per clause. For example, in the sentence, "The distribution of rock types is a reflection of the rock cycle," (Houghton Mifflin Company, 2005, p. 80) there are seven content carrying lexical words and one clause; therefore, the sentence has a lexical density score of 7.0. Contrast this to a different sentence, "The largest particles dropped out when the water was moving quickly" (Houghton Mifflin Company, 2005, p. 94). The second example also has seven content words but two clauses so the lexical density score is 3.5. This measure will be discussed further in Chapter Three and used in a later section of this paper to analyze elementary and middle school science passages. Of all types of language, informal spoken discourse has the lowest lexical density followed by written

discourse. Written science discourse possesses a higher level of lexical density than other written forms, which contributes to comprehension difficulty as early as upper primary school (Halliday, 1996a) and can cause a delay in textual understanding as students move into the middle school years and beyond (Fang, Lamme, & Pringle, 2010).

Science texts contain an air of authoritativeness as a result of several grammatical components. A tone of assertiveness in science passages is achieved through the use of declarative sentences over interrogative or imperative sentences (Fang, 2008). Also, instead of mentioning explicit persons, generalized participants are mentioned (e.g., *scientists, chemists, biologists, miners*), which contribute to the impersonal quality of the text. By applying this essential organizational feature, the author can refrain from using specific human or animal actors, thus maintaining a level of authoritativeness and objectivity (Fang, 2006). Removing the actors can also protect the identity of those responsible for certain actions. For example, in order to hide the actor, the text can read, *"Ores of copper and of iron <u>are obtained</u> by open-pit mining,"* instead of saying, *"Miners use open-pit mining to obtain ores of copper and of iron"* (Houghton Mifflin Company, 2005, p. 65). The passive voice is necessary in science writing to emphasize processes and results instead of who is doing the action. However, it can have an alienating effect on the reader as it does not require personal involvement or include interactive language (Fang, 2008).

The language of science has a high level of abstraction (Christie, 2002; 2012; Derewianka, 1992; Fang, 2004; 2008; Fang, Lamme, & Pringle, 2010; Fang & Schleppegrell, 2008; Halliday & Martin, 1996). Abstractions occur when concrete

processes are turned into abstract participants. Nominalization is a prevalent type of abstraction that is likely to create a participant. Research states that scientific writing contains large numbers of nominalizations because of their importance in the design of scientific texts (Halliday & Matthiessen, 2014; Kazemian, et al., 2013). Fang, Lamme, and Pringle (2010) note that in grades three through eight, students will notice abstractions more often in scientific texts than in narrative texts or in social interactions. It is for these reasons that the analysis of nominalizations was chosen for the current study. Nominalizations will be discussed in greater detail in the next section of this chapter.

The features and uses of science texts have been extensively studied; however, little research is available on the prevalence and the implications of nominalizations in elementary science textbooks. The current study extends the research of science text features to both elementary and middle school science texts.

Grammatical Feature: Nominalization

Of the many characteristics of scientific discourse, nominalizations are one of the most distinctive and frequently utilized (Halliday 2004; Kazemian, et al., 2013). In fact, many of the features of science text are direct results of nominalizations because nominalizations contribute to lexical density, condensation (condensing entire processes into one word), objectivity (removing the need to use persons or personal pronouns), and technicality (the construction of technical terminologies) (Kazemian, et al., 2013). In *The Concise Oxford Dictionary of Linguistics* (Matthews, 2014, para. 1), nominalization is defined as “any process by which a noun or a syntactic unit with the functions of a noun

phrase is derived from any other kind of unit." Typically, nouns describe entities. However, when a writer wants a noun to signify a process or a quality, a nominalization is used (Halliday, 2004). This grammatical form is classically created when an event, a process, a description, or a procedure represented by a verb, an adjective, or an adverb is converted into an abstract thing represented by a noun (Fang, 2004). For example, in the following sentence from *Earth's Surface* (Houghton Mifflin Company, 2005) the underlined nominalization, *composition*, is used to describe a process instead of the verbal structure, *compose*, "The composition of a soil determines what you can grow in it" (p. 123). The analysis of nominalization is important to the current study because I will be investigating the occurrence and implications of nominalizations in elementary and middle school science texts.

Nominalization as a Grammatical Metaphor

Nominalizations are often referred to as a type of *grammatical metaphor* (Halliday & Matthiessen, 2014). Halliday (1996a) explains that a grammatical metaphor is similar to a traditional metaphor in the sense that there is a substitution of one thing for another. But in this case, instead of substituting one word for another, a grammatical metaphor substitutes one grammatical class for another as well as creates a variation in the expression of the meaning (Kazemian, et al., 2013). The opposite forms, labeled *congruent*, occur when the elements of grammar are conforming to their characteristic functions (Christie, 2012). That is, based on the framework of SFL, nouns behave as things and entities and verbs show actions, behaviors, and thoughts whereas circumstances communicate *where*, *when*, and *why* typically indicated by prepositional

phrases, adverbs, or adverb clauses. By labeling the nouns and actors in a sentence *participants,* by calling the verbs *processes,* and by referring to prepositional phrases, adverbs, or adverb clauses as *circumstances,* a standard subject-verb-object sentence with participant-process-participant-circumstance order can be observed to show a congruent form of grammar (Table 3). And, a non-congruent, metaphorical means of writing the same information can be seen in Table 4.

The bolded elements in Tables 3 and 4 show how the part of speech has changed from verbs in the congruent version to nouns in the non-congruent version. The verb *add* has been changed to the noun *addition*, the verb *pollute* has become the noun *pollution*, and the verb *drains* has changed to *drainage.* The information in the two versions has not changed, but the linguistic form has been altered and the pragmatic meaning has possibly been construed differently. Since the bolded elements of grammar in the second version have changed to an alternate configuration and ceased conforming to their characteristic functions, they are considered grammatical metaphors (Christie, 2012).

Table 3

Congruent Form of Grammar

Participant (noun/noun phrase)	Process (verb/verb phrase)	Participant (noun/noun phrase)	Circumstance
Farmers	**add**	nutrients	to the soil with organic fertilizer
Fertilizers	can **pollute**	the water	when rainwater **drains** into rivers lakes, and oceans.

Table 4

Non-Congruent, Metaphorical Form of Grammar

Participant (noun/noun phrase)	Process (verb/verb phrase)	Participant (noun/noun phrase)	Circumstance
The **addition** of nutrients to the soil with fertilizers	can cause	water **pollution**	from rainwater **drainage** into rivers lakes and oceans

Conversely, a similar process called *agnation*, is used with grammatical metaphors to convert nominalizations to non-nominal, congruent structures. *Agnate* is a term that refers to a traceable relation (Agnate, 2015). Therefore, one purpose of agnation is to permit someone to determine the 'natural habitat' (Heyvaert, 2003, p. 68) of a nominalized word and to show the relation between a nominalization and its congruent structure. Sentence (1) contains an example of a metaphoric nominalization, *condensation*.

(1) "*You observed <u>condensation</u> when water vapor formed droplets on the outside of a cup of ice water"* (FOSS, 2012, p. C78).

The congruent agnate of the sentence could appear as

(2) *You observed how gas <u>condensed</u> into liquid when water vapor formed droplets on the outside of a cup of ice water."*

Part of one of the research questions in this study aims to determine how nominalization might change the syntax of a text. It is known that nominalizations condense clauses to make the writing more economical thereby altering the syntax through the condensation (Thompson, 1996). On the other hand, the syntax of a sentence

is also changed by returning the nominalization to its original verb or adjective form. It can be said that this unpacking of the metaphors contributes to greater syntactic complexity because more subordinate clauses are produced when a congruent agnate is created (Thompson, 1996). Additionally, since it is known that nominalizations change the semantics of a text (Martin, 1996), the formation of congruent agnates may indicate how nominalizations alter the semantics of a text. Therefore, this method of creating congruent agnates, which will be discussed further in Chapter Three, is important to the study because it attempts to show how nominalization might change the syntax and semantics of a text.

Purpose of Nominalization

There are many purposes of nominalizations in science texts. Science writing uses nominalizations to turn processes and actions into abstract objects and remove human participants (Baratta, 2009), to create textual cohesion, to compact information to make the material more concise (Schleppegrell, 2004), and to avoid repetition of verbs.

Abstraction is created by utilizing a nominalized participant so there is no need to designate an actual person, place, or thing involved with the process (Schleppegrell, 2004).

(3) ***Farmers*** *add nutrients to the soil with organic fertilizer. Fertilizers can pollute the water when rainwater drains into rivers, lakes and oceans.*

(4) ***The addition*** *of nutrients to the soil with fertilizers can cause water pollution from rainwater drainage into rivers, lakes, and oceans.*

Example (3) shows a human participant, *farmers,* as the subject of the sentence whereas example (4) displays an abstract participant, *the addition,* as actor in the sentence. This use of nominalization can remove the responsibility from a human participant and leave an unmentioned agent of blame by objectifying the process (Kazemian & Hashemi, 2014). Abstraction also allows scientists to create theoretical entities (Fang, Lamme, & Pringle, 2010). The underlined nominalization, *pollution,* transforms to an abstract noun that incorporates a process from the original verb. This allows the author to communicate information in a more flexible way (Fang & Schleppegrell, 2008).

Another way nominalizations are used in science texts is through the process of cohesion. Cohesion describes how the elements of a text come together in a unified manner (Eggins, 2004). Instead of reiterating the entirety of preceding information, nominalizations assist in moving the text along by compressing the writing (Cameron, 2011; Halliday, 1996b). After a process has been introduced in a text, it can be encapsulated as a thing and be used as the basis for the next point in the text or become a participant in another process in the text (Thompson, 1996). This creates 'discursive flow' (Derewianka, 1990; Fang, Schleppegrell, & Cox, 2006) by which one sentence seamlessly transitions into the next. An example of this can be seen in (5) where the word *wedging* is defined:

(5) "When water freezes, in the cracks and pores of rocks, the force of its expansion is strong enough to split the rocks apart. This process is called *wedging*. Ice *wedging* is common in places where temperatures rise above

> and fall below the freezing point for water" (Houghton Mifflin Company, 2005, p. 116).

As can be seen, *wedging* does not need to be re-explained in the third sentence as the entire process has been compacted into one word. Furthermore, the nominalized noun form *wedging* creates a relationship between the definition in the first sentence and the information that comes later in the text. This can also allow the nominalization to become a participant in another process (Kazemian & Hashemi, 2014).

English nouns are extremely versatile. They can be used to count, classify, describe, specify, and quantify (Eggins, 2004). For this reason, while each clause only allows one verb, it can hold multiple nouns. Thus, by nominalizing verbs in writing, more information can be packed into each clause so that the noun phrases can extend and carry more content (Eggins, 2004; Derewianka, 1990). This addition or modification of a simple noun phrase can occur through multiple measures such as by adding a post-modifying prepositional phrase to a noun or to a nominalization (Fang, Schleppegrell, & Cox, 2006; Biber, et al., 2011). However, the end result is similar. The noun phrase becomes increasingly more complex each time more information is inserted into the phrase (Fang, Schleppegrell, & Cox, 2006; Biber et al., 2011). An illustration of this can be observed in examples (3) and (4) about water pollution. The underlined sections illuminate how prepositional phrases can modify the nominalizations. In example (3) there are two sentences and two separate clauses and in example (4) the information has been condensed to inhabit only one clause by use of the lengthy noun phrases.

Occasionally, when a congruent form is converted to a metaphoric form, the newly created nominalizations are able to take on post-modifying prepositional phrases that show agency or force. The notion of an *agent* or an *actor* describes a specific semantic role (or a thematic role) between a predicate and an argument (Brinton, 2000; Tallerman, 2013). An agent is the initiator or causer of an action. Agency is typically expressed by a subject noun phrase; in limited cases it can be the object of the preposition *by*. Initiators or causers of actions can be inanimate, as in examples (6) and (7), or animate as in examples (8) and (9). The term *force* signifies the former and the term *agent* the latter (Brinton, 2000). In the current study, the data will be examined with respect to both.

(6) When soil erodes excessively, rivers deposit the sediment into the ocean.

(7) A problem caused by excessive soil erosion is the deposition of sediment <u>by rivers</u> into the ocean.

(8) Einstein developed the theory of relativity.

(9) The theory of relativity was developed <u>by Einstein</u>.

In the congruent example (6), *rivers* is the force because it is clearly the inanimate causer of the action in the sentence and the force behind the action. In the metaphorical example (7), a nominalization has been used followed by a post-modifying prepositional phrase that shows inanimate force. Even though the sentence structure has been changed, *rivers* is still the subject and the inanimate force of the sentence. Since *rivers* is part of a prepositional phrase modifying the nominalization *deposition*, this makes *by rivers* a prepositional phrase that shows force. Just like the force is the same in examples (6) and

(7), the animate agent is the same in both example (8) and (9). Although example (9) is the passive form of example (8), *Einstein* is still the agent since *Einstein* is the actor.

Research has been conducted around nominalization and noun phrases (Fang, Schleppegrell, & Cox, 2006; Biber et al., 2011). However, nominalizations which are modified by prepositional phrases that show agency or force have not been adequately studied in elementary and middle school science texts. Therefore, the present text analysis will tally the frequency with which nominalizations are modified by prepositional phrases that show agency or force in order to discuss how nominalizations affect noun phrase complexity.

Types of Nominalization

Although various researchers indicate several types of nominalizations (Hartnett, 1998; Humphrey, et al., 2012; Rodby & Winterowd, 2005), for the purposes of this study, I will only explain the following forms a) nouns and verbs spelled alike, b) gerunds, c) verbs to nouns, and d) adjectives to nouns.

The first category is a single word that can have an identically spelled noun form and verb form. This can also be called a functional shift (Functional shift, 2007):

> Verb form: *A sedimentary rock may **change** to slate near the surface.*
>
> Noun form: *A metamorphic **change** occurs over large areas in which both temperature and pressure are high.*

Orally, some of these words have stress patterns that can separate one from the other (Hartnett, 1998; Humphrey, et al., 2012). For example, the word *refund* is pronounced

differently depending on whether it is used as a verb or as a noun. As a noun, it is pronounced *REfund* with the stress on the first syllable as in, "I would like a refund, please." As a verb, it is pronounced *reFUND* as in "I can refund you 25%." In written form, however, the stress is impossible to distinguish and only context can determine to which grammatical category each form belongs.

The second category is a gerund, which receives a morphological –ing ending to change it from a verb root to a noun form (Hartnett, 1998; Humphrey, et al., 2012). However, to be a gerund, the word has to be used as a noun. For example, *Slow **cooling** allows time for large mineral crystals to form.* In this sentence, the suffix *-ing* has been added to the verb *cool* thus creating a gerund.

The third category includes verbs changed to nouns with a suffix other than -ing. This requires the addition of a suffix to the verb form or a modification of the verb root (Hartnett, 1998; Humphrey, et al., 2012; Rodby & Winterowd, 2005). Some examples of suffixes added to the verb form are *–ion* (*precipitate* to *precipitation*), *-er* (*mine* to *miner*), *-ment* (*move* to *movement*), *-ure* (*mix* to *mixture*).

The fourth category turns adjectives into a noun form. This requires the addition of a suffix to an adjective, which can be seen in the following examples: *tense* to *tension* (-ion) and *dense* to *density* (-ity).

Challenges of Nominalization

Nominalizations create challenges for readers for a number of reasons. First of all, because nominalizing processes can remove the actor from the writing, the true

meaning may be lost to readers (Fang, 2004). Thus, the skill of inferencing becomes more critical as the semantic information becomes hidden in ambiguity. Secondly, highly nominalized excerpts make it difficult for readers to unpack the information embedded in the text (Fang, 2006; Kazemian, et al., 2013) because there is much more information to process per clause. A third reason abstractions present challenges is that both the semantics and the grammar change through nominalizations (Martin, 1996). In congruent English, verbs are processes, adjectives are descriptions, nouns are participants, etc. However, nominalizations can shift the grammar so that the verb process *accumulate* becomes the noun process *accumulation*. The added complexity of this realization is that the metaphorical nominalization *accumulation* actually has two layers of meaning (Halliday and Matthiessen, 2014). Not only does it semantically mean a thing (*accumulation*) but also a process (the congruent meaning *accumulate*).

Although much is known about the purpose, the types, and the challenges of nominalization, little is known about the use of nominalization in elementary science texts nor how this grammatical feature affects sentence and noun phrase complexity in elementary science texts. The present text analysis encompasses the study of nominalizations across both elementary and middle school science textbooks. One means of researching a linguistic feature like nominalization is by conducting a text analysis. The next section defines text analysis and feature analysis and shows how text analyses can be used in the classroom.

Text Analysis

A text analysis allows an investigator to study how the features of written language affect the meaning of the text by analyzing the patterns of language in the writing (Barton, 2004; Halliday & Matthiessen, 2014). It falls under a wider study called discourse analysis, which includes spoken talk and conversation. Through investigating text features at the sentence level or as broad as the genre level (Barton, 2004), researchers can identify how individuals produce texts and text genres and can study their reliance on and promotion of certain types of texts. They can also determine how people learn to read texts and how meaning is created through various linguistic, rhetorical, and pictorial means (Bazerman and Prior, 2004). The types of text analysis span from literary and rhetoric examinations to Biblical, legal and linguistic studies (Bazerman & Prior, 2004).

The overall purpose of text analysis for individuals involved with English for Academic Purposes (EAP) is to concentrate on syntactic discourse features in order to assist non-native English learners (Swales, 1990). Frequently, quantitative textual studies analyze the function of language by calculating the frequency of various linguistic elements to determine what should be taught in EL curriculum (Swales, 1990). Based on SFL, part of the function of language focuses on the structure alone while another part of the function of language includes the meaning. As mentioned in Chapter One, certain instruments based on the SFL framework place emphasis on nominalization such as transitivity (Thompson, 1996) and lexical density (Halliday, 1996a). These tools are often used to conduct linguistic text analyses to determine how meaning is affected by the

language structures used in a text (Fang & Schleppegrell, 2008). The SFL framework is applicable to text analyses because it explains how language is used in different contexts and it affirms that structure and syntax combined with meaning come together to create a message (Halliday, 1985). Therefore, in order to determine how nominalization might affect the syntax and semantics of a text and in order to determine how nominalization might contribute to lexical density, tools from the SFL framework will be used throughout this linguistic text analysis.

Use of Text Analysis in the Classroom

Teachers and students alike can use text analysis to assist comprehension by observing text organization and the elements of written texts to see what the text does and what it means (Bazerman & Prior, 2004; Connor, 1994). Teachers, specifically, can analyze one text or compare multiple texts to determine what language structures may prove challenging for their students (Sanders & Sanders, 2006; Schleppegrell, 2004). Schleppegrell (2010) hails the importance of conducting text analysis to hone in on the patterns of language that students will find in school textbooks or in various school genres. By asking questions such as *'What's going on in this text? How is the text organized?'* teachers can discover what is important to teach students about the way that academic language functions in the school curriculum (Schleppegrell, 2010).

While text analyses have been performed on elementary (Fang Lamme, & Pringle, 2010) and middle school (Fang, 2006; Fang, 2008) science texts, little attention has been spent on comparing the use of nominalization across grade levels in science

textbooks. The current study will examine how nominalizations occur in various levels of science texts.

The Gap

As presented in the chapter above, considerable research has been conducted in the areas of science texts and their features, nominalization, and text analysis. However, to the best of my knowledge, no studies have analyzed the existence and implications of nominalizations in specific grade-level science texts. In a research study completed in 2003, Beverly Derewianka analyzed all the texts written by her son from age five to age thirteen to look for instances of grammatical metaphor production. Her work shows that there is an increase in usage of nominalization beginning at age nine. Earlier findings by Halliday (1985) conclude that children are able to comprehend grammatical metaphors about nine to ten years of age and they can produce them at about fourteen to fifteen years old. More current research has also determined that children are liable to encounter grammatical metaphors in upper elementary school (Halliday & Matthiessen, 2014).

Recent studies have looked at school-age texts including high school science textbooks (Derewianka, 1992), the demands of science reading in middle school (Fang, 2006; Fang et al., 2010) and high school (Fang & Schleppegrell, 2008; 2010), science writing in the upper primary levels (Halliday, 1996a), and the linguistic challenges of expository reading in the intermediate grades (Fang, 2008). Similarly, Butler et al. (2004) analyzed nominalizations, among other linguistic characteristics, in fifth grade science, math, and social studies textbooks with the purpose of informing curriculum and

assessment design appropriate for fifth grade. However, previous research has not addressed what nominalizations in science texts look like across grade levels.

Therefore, this present study was designed to evaluate at which point nominalizations begin to occur in grade-level science passages by analyzing and comparing the occurrence of nominalizations in leveled explanation passages from elementary and middle school science textbooks, and to determine how nominalization affects sentence and noun phrase complexity of a text. Although there are many characteristics of nominalization that could be researched, the focus of this study will be identifying how the reduced number of clauses in passages with nominalization creates lexical density.

Research Questions

The purpose of this study is to analyze and compare the occurrence of nominalization in leveled explanation passages from elementary and middle school science textbooks and to determine how nominalization affects the syntactic and semantic complexity of a text.

The following questions will guide the analysis:

How might nominalization contribute to the sentence structure and noun phrase complexity in first through fifth grade and middle school science textbooks?

- How many examples of nominalization are found in each of the intended levels of texts and what could this indicate?
- Which types of nominalizations are found in each level of science texts and what could this imply?

- How frequently are nominalizations modified by a prepositional phrase that shows agency or force?
- How might nominalization affect the syntax and semantics of the text?
- How might nominalization contribute to lexical density?

Summary

Chapter Two referenced previous studies related to my topic. Such topics included the features and purposes of science texts, the purpose, types and challenges of nominalization, and an overview of text analyses and their use in the classroom. By indicating the perceived gap in the research, a niche was established to evaluate the appearance of nominalizations in grade-level science text through an analysis and comparison in leveled explanation passages and to determine how nominalization may affect sentence and noun phrase complexity. Guiding research questions were also identified that will drive the forthcoming text analysis. The data collection methodology will be presented in Chapter Three. The purpose of the study will be explained as well as an overview of trial research using the chosen analysis tools.

CHAPTER 3: METHODOLOGY

One aim of this paper is to analyze the incidence and types of nominalizations in elementary and middle school science textbooks. The main objective is to determine how these nominalizations affect sentence and noun phrase complexity both from a syntactic and a semantic perspective. The following question and sub-questions will guide the text analysis:

How might nominalization contribute to the sentence structure and noun phrase complexity in first through fifth grade and middle school science textbooks?

- How many examples of nominalization are found in each of the intended levels of texts and what could this indicate?
- Which types of nominalizations are found in each level of science texts and what could this imply?
- How frequently are nominalizations modified by a prepositional phrase that shows agency or force?
- How might nominalization affect the syntax and semantics of the text?
- How might nominalization contribute to lexical density?

The hypothesis is that a progression of nominalization occurrences exists in school science textbooks. That is, I predict that nominalizations will begin appearing more frequently in the upper elementary grades, appearing around fourth or fifth grade. The

claim is that this appearance affects sentence and noun phrase complexity. This is a broad generalization since only seventeen texts will be analyzed from the following levels: first through fifth grade and middle school.

Chapter Overview

This chapter covers an introduction of the methodologies used in this study. It begins with an overview of the research paradigm including both the quantitative and qualitative aspects. Next, the texts included in the study are introduced along with the rationale for using them. Following that, the methods for data collection are presented along with an explanation of the research instruments used in the pilot study. Lastly, an explanation for how the data will be verified is included to show how the methods used in this study are both valid and reliable.

Research Paradigm

Text Analysis as a Content Analysis

The current study is a text analysis of leveled explanation science texts. By definition, a text analysis concentrates on "what texts do and how texts mean" (Bazerman and Prior, 2004, p. 3). The investigation will look at both how nominalizations operate in texts as well as how nominalizations affect meaning. The particular type of analysis I will be conducting is most similar to a category of text analysis called a content analysis. According to Thomas Huckin (2004), content analysis is "the identifying, quantifying, and analyzing of specific words, phrases, concepts, or other observable semantic data in a text…with the aim of uncovering some underlying thematic or rhetorical pattern" (p. 14).

Although many research paradigms can be categorized as either quantitative or qualitative, the beauty of a content analysis is that is joins both methods together to include objective syntactic data as well as impressionistic observations (Huckin, 2004). Thus, various aspects of qualitative and quantitative designs will be discussed with attention given to the characteristics that fit the present study.

Quantitative Aspects

This text analysis includes elements typical of quantitative research. Research that is quantitative in nature often begins with an explicit research question and a hypothesis to prove (McKay, 2006). Although there are also sub-questions to be answered, the specific research question for this thesis is: *How might nominalization contribute to the sentence structure and noun phrase complexity in first through fifth grade and middle school science textbooks?* Accordingly, a hypothesis has also been indicated: The occurrence of nominalization will affect the parts of speech and alter the pragmatics of the text thus increasing the lexical density and influencing sentence and noun phrase complexity.

Based on preliminary investigations, I additionally hypothesize that there will be an increase in observed nominalization occurrences from the first grade passage to the eighth grade passage which will influence sentence and noun phrase complexity as the levels of science texts progress.

Another aspect of quantitative research is its reliance on numerical data and variables (Mackey & Gass, 2005). In the current study, the numbers and types of nominalizations in each level will be counted and compared. The lexical density will be

calculated as well. Although the abovementioned features bring reliability to an analysis, the contextual meaning is disregarded if a qualitative approach is not also included (Huckin, 2004).

Qualitative Aspects

Similarly, this text analysis also is related to qualitative research. Characteristically, qualitative research focuses more on an interpretive analysis over a statistical analysis of the data (McKay, 2006). General conclusions are made based on observations using detailed descriptions (McKay, 2006; Mackey & Gass, 2005). Although I will be counting instances of nominalization, in this study, I will also be looking at the semantic and syntactic properties of the text, which allows insight into the contextual meaning of the texts.

Quantitative and Qualitative Content Analysis

The abovementioned elements contribute to categorizing the current study. Thus, it can be said that this text analysis is neither exclusively qualitative nor quantitative but rather both quantitative and qualitative. Previous studies by McKay (2006), Huckin (2004), and others mention that these traditions can be joined to create a unique research paradigm. As a result, I will begin with a hypothesis and utilize both quantitative and qualitative evidence to verify the prediction. My research will include some quantitative counting and sorting of data to complement my syntactic and semantic observations of how nominalizations behave in elementary and middle school science textbooks.

Texts Included in the Study

It has been said that of all the resources used in the classroom, textbooks are the most influential (McKay, 2006). Thus, textbooks were chosen for this study based on the probability of their use with students, on their authenticity, and on their impact in the classroom. A defining feature of a textbook's design is that each one is written for a specific grade level, often with grade-specific content, which allows a comparison to easily be made between the writing of various levels. Because text analyses can investigate comparisons of similar texts (Sanders & Sanders, 2006), multiple levels of a similar topic with similar numbers of words have been selected for evaluation. The word count and the topic selection will operate as benchmarks so it can be determined how many examples and types of nominalization are seen a certain type of text (Kazemian, et al., 2013).

Seventeen texts from the first to the eighth grade level will be examined to identify and count occurrences of nominalizations and to determine any noticed patterns. Since each textbook publisher includes varied amounts of information and individual grade levels require varying text lengths, the selected texts have a wide range of word counts. Because science explanations organize clauses using grammatical metaphors (Schleppegrell, 2004), all the chosen selections are explanations of erosion and weathering. The passages have been taken from *Houghton Mifflin Science Discovery Works* (Badders, et al., 2003), *Houghton Mifflin Science* (Badders, et al., 2007), *Teacher's Edition Concepts and Challenges Earth Science* (Bernstein, et al., 2009), *Scott Foresman Science* (Cooney, et al., 2000), *Macmillan McGraw-Hill Science* (Daniel, et

al., 2005), *Glencoe Science Earth Science* (Feather, Snyder, & Zike, 2008), *Earth's Surface* (Houghton Mifflin Company, 2005), and *Teacher's Edition Prentice Hall Earth Science* (Tarbuck & Lutgens, 2006) all by major publishers. These titles were chosen based on the availability of information on the topic of erosion and weathering. It proved difficult to find second grade textbooks with material on the selected topics. For this reason, it was decided to combine the only encountered second grade selection with a first grade selection by the same publisher. Since both of these selections had a low word count, the combination of the two texts was more comparable to the length of the other first grade texts that were found. Due to the scope of this study, only five of the initial seventeen textbook selections will be used to create congruent agnates, to calculate the lexical density, and to conduct a process/participant analysis. These texts are *Scott Foresman Science* (Cooney, et al., 2000) Volumes 1, 3, 4, and 5, and *Teacher's Edition Prentice Hall Earth Science* (Tarbuck & Lutgens, 2006). These selections were chosen because they all have information on weathering. In each of these texts, only the first five sentences containing a nominalization will be used.

Data Analysis

Methods

As mentioned in Chapter Two, systemic functional linguistics looks at both the form (syntax) and certain semantic and pragmatic functions of language. Consequently, this study will focus on the grammatical structure of nominalization as well as how the grammatical structure affects meaning. Both of the analyses in this study are based on the theoretical framework of SFL applied to nominalizations in elementary and middle

school science explanations. In five stages, the text analysis process will show how nominalizations complicate texts by illustrating the kinds of nominalizations in texts and by identifying how the reduced number of clauses in passages with nominalization creates lexical density.

Stage number one is based on an analysis that Butler et al. (2004) conducted on academic English in fifth grade texts. It will include tallying the number of nominalizations from each selection in the corpus of texts and arranging the examples in a chart by type to code any noticed patterns. The types of analyzed nominalizations will include gerunds, verbs to nouns, and adjectives to nouns. Neither functional shifts (nouns and verbs spelled alike) nor clauses to noun groups will be analyzed, as these forms are beyond the scope of this study. Only nominalizations that undergo a morphological shift will be included in this research. The number of nominalizations modified by a prepositional phrase will also be tallied and compared. Additionally, the number of nominalizations in each text will be divided by the number of words in each selection to calculate the percentage of nominalizations for each text. This percentage will be rounded up to the nearest tenth.

In stage number two, the five aforementioned textbook selections will be used to create congruent agnates of each clause in possession of a nominalization and to note the types of grammatical shifts present. This is suitable to the research because it is essential to analyze the metaphorical form against the "background of its congruent variant" (Halliday & Matthiessen, 2014, p. 710) in order to entirely understand the meaning of a nominalization. In other words, because agnation situates a nominalization in its 'natural

habitat' (Heyvaert, 2003, p. 68), a number of functional insights can be gained through a comparison of the congruent agnates and their nominalization counterparts. Careful attention will be given to ensure that the overall message of each sentence is maintained even though the wording will change. However, since it is likely that each researcher could potentially craft different congruent versions of the text, another researcher will investigate a portion of the data, which will then be compared with my analysis to verify external inter-rater reliability.

In stage number three, nominalizations will be investigated to determine if they are post-modified by prepositional phrases that show agency or force. In order to uncover possible agents or forces which may be hidden inside prepositional phrases, the congruent versions will be observed. This is suitable to the research since nominalizations that allow post-modifying prepositional phrases could affect noun phrase complexity.

Stage four will include a process/participant analysis (see Halliday, 1996a; Schleppegrell & de Oliveira, 2006), also called a transitivity analysis (Eggins, 2004), of both the metaphorical and congruent clauses in only the five chosen textbook selections. According to Eggins (2004), a transitivity analysis determines the "processes (actions, events, mental processes, and relations expressed by verbs), participants (people, animals, concrete and abstract objects that take part in processes expressed by nouns), and circumstances (time, place, manner, cause, condition expressed by adverbs and by prepositional phrases)" in each clause to investigate the structure (p. 80). This is useful for the research to illustrate how various shifts are occurring in a grammatical metaphor

and to specifically show how nominalization shifts the processes to participants or to circumstances in the metaphorical clauses. While the shift in grammatical class will be studied in this analysis, the shift in semantic type will not be analyzed.

In stage five, the lexical density of both the metaphorical and congruent texts will be calculated and compared in only the five chosen textbook selections. In a pilot study conducted as part of this research, two forms of calculating lexical density were attempted. There have been several attempts to define lexical density, each with its own pros and cons. One method, as explained by Suzanne Eggins (2004), involves calculating the content-carrying words (nouns, verbs, adjectives, adverbs) and dividing the total by the number of words in the excerpt. The second method, described by Halliday & Matthiessen (2014) consists of dividing the number of content words or lexical items by the number of clauses in the text. For the purposes of this research, I have chosen the Halliday's method of lexical complexity for the actual analysis since the results in the pilot study were more defined using this calculation. For the current study, a clause will be defined as a group of words that contain a noun and a verb. Embedded clauses will not be tallied in the clause count.

An additional sixth stage will take the previously collected data from the first through fifth grade, and middle school texts and will compare the results across the grade levels. The selections will be analyzed to look for differences in number and type of nominalizations.

The aforementioned stages were developed by completing a preliminary study. During the course of the pilot study, the steps were fine-tuned to best show how

nominalizations complicate texts. This was done through the counting and identification of the types of nominalizations in texts, through the tallying and comparison of nominalizations modified by a prepositional phrase, through the calculation of lexical density, and through the comparison of texts across grade levels.

Pilot Study

The various tools to elicit data in the current text analysis were piloted using a fourth grade excerpt from FOSS Science Resources (2012). Verbs to nouns are underlined, **gerunds** are bolded, and adjectives to nouns are underlined twice:

> Refraction
>
> Light travels at different speeds. It moves very fast through air, but it moves slowly through things that are more dense than air. The more dense the substance, the more slowly light travels through it. That's why a light ray moving through water, plastic, or glass seems to bend. These materials are more dense than air. We call this **bending** of light rays refraction.
>
> A hot surface can change the density of air just above it. When that happens, light is refracted where the hot air meets a layer of cooler air. The refraction makes you think you see something that is not there. This illusion[1] is

[1] Although *illusion* appears to be a nominalization, there is no modern, congruent verb form of *illusion*. *Illusion* comes from an archaic verb *illude. Illusion* was a nominalization at some point in history, but since there is not a current congruent verb, it cannot be categorized as a nominalization.

called a mirage. On some days, you might see a mirage that looks like a pool of water above a hot, paved road that is completely dry. (p. 78).

By applying the previously explained methods from stage one, the number of nominalizations were counted and a percentage was gathered. There were a total of five nominalizations in the selection with 135 words overall. Therefore, the percentage of nominalizations equaled 3.7 percent. The unique nominalizations were then color-coded by type (Table 5). Subsequently, the number of nominalizations with post-modifying prepositional phrases was counted. In this selection, two of the five nominalizations were followed by prepositional phrases (Table 6). However, neither of these two examples are agency or force-showing prepositional phrases.

Table 5

Pilot Study: Nominalization Types for Pilot Study

Unique nominalization	Type of nominalization
bending	**gerund**
refraction	verb to noun
density	adjective to noun

Table 6

Pilot Study: Nominalizations Followed by a Prepositional Phrase

Nominalization	Prepositional Phrase
bending	of light rays
density	of air just above it

Based on the earlier stated analyses of stage two, a congruent agnate was created as well as a comparison chart of the metaphorical phrases beside their congruent counterparts (Table 7). Only four sentences were selected for the analysis on account of their inclusion of nominalization. The other sentences in the selection are insignificant to this part of the study.

Metaphorical Wording:

We call this **bending** (1) of light rays refraction (2). A hot surface can change the density (3) of air just above it. When that happens, light is refracted where the hot air meets a layer of cooler air. The refraction (4) makes you think you see something that is not there.

Congruent Wording:

When light *bends*, we say that the light rays have *refracted.* A hot surface can change the air just above it to make it *more dense*. When that happens, light is refracted where the hot air meets a layer of cooler air. The light has *refracted* and makes you think you see something that is not there.

Table 7

Pilot Study: Side by Side Comparison of Metaphorical and Congruent Phrases

No.	Metaphorical wording	Congruent wording
1	this *bending* of light rays refraction	the light *bends*
2	this bending of light rays *refraction*	light rays have *refracted*
3	the *density* of air just above it.	the air just above it is more *dense*
4	The *refraction*	The light has *refracted*

Afterwards, using an analysis similar to an approach by Kazemian, et al. (2013), the shift in grammatical class was noted (Table 8).

Table 8

Pilot Study: Shift in Grammatical Class

No.	Congruent wording	Metaphorical wording
1	Verb (bends)	Noun (this bending)
2	Verb (refracted)	Noun (refraction)
3	Adjective (dense)	Noun (density)
4	Verb (refracted)	Noun (refraction)

Next, both the metaphorical and the congruent forms of the five selected sentences were broken down into individual clauses and lined up according to processes, participants, and circumstances (Tables 9 & 10). The number of clauses in each form was also tallied.

Table 9

Pilot Study: Process/Participant Analysis for Metaphorical Wording

Sentence No.	Connector	1st Participant	Process	Other Participants	Circumstance
1		We	call	this *bending* of light rays	
				refraction	
2		A hot surface	can change	the *density* of air	just above it
3	When	that	happens		
		light	is refracted		
	where	the hot air	meets	a layer of cooler air	
4		The *refraction*	makes		
		you	think		
		you	see	something	
		that	is not		there

Table 10

Pilot Study: Process/Participant Analysis for Congruent Wording

Sentence No.	Connector	1st Participant	Process	Other Participants	Circumstance
1	When	light	*bends*		
		we	say		
	that	the light rays	have *refracted*		
2		A hot surface	can change	the air	just above it to make it more *dense*
3	When	that	happens		
		light	is refracted		
	where	the air	meets	a layer of cooler air	
4		The light	has *refracted*		
	and	(it)	makes		
		you	think		
		you	see	something	
		that	is		not there

From the data it can be seen that the metaphorical wording in Table 9 has nine clauses whereas the congruent wording in Table 10 has thirteen clauses.

Finally, the lexical density of both of the selected metaphorical and congruent sentences was calculated (Tables 11 & 12). This was done by highlighting the content

words, counting the number of words and clauses, and tallying the results on a chart. As mentioned before, both Eggins' (2004) and Halliday and Matthiessen's (2014) methods were employed for the pilot study.

Table 11

Pilot Study: Eggins' Lexical Density Calculation

	Metaphorical Paragraph	Congruent Paragraph
NOUNS/PRONOUNS	19	18
Verbs	9	13
Adjectives	4	5
Adverbs	0	0
Total Content Words	32	34
Total Words	48	57
Lexical Density	**32/48=0.67**	**34/57=0.60**

Table 12

Pilot Study: Halliday's Lexical Density Calculation

	Metaphorical Paragraph	Congruent Paragraph
NOUNS/PRONOUNS	19	18
Verbs	9	13
Adjectives	4	5
Adverbs	0	0
Total Content Words	32	34
Total Clauses	10	13
Lexical Density	**30/10=3.2**	**36/12=3.0**

Congruent Wording:

When LIGHT bends, WE say that the *light* RAYS have refracted. A *hot* SURFACE can change the AIR just above IT to make IT more *dense*. When THAT happens, LIGHT is refracted where the *hot* AIR meets a LAYER of *cooler* AIR. The LIGHT has refracted and makes YOU think YOU see SOMETHING THAT is not THERE.

Metaphorical Wording:

WE call this BENDING of *light* RAYS REFRACTION. A *hot* SURFACE can change the DENSITY of AIR just above IT. When THAT happens, LIGHT is refracted where the *hot* AIR meets a LAYER of *cooler* AIR. The REFRACTION makes YOU think YOU see SOMETHING THAT is not THERE.

The final stage was not appropriate for the pilot study since only one text was analyzed for the trial. This comparison piece of the investigation will be applied during the formal analysis.

Based on the pilot study, Halliday's method of lexical density calculation will be used for the actual analysis. Halliday and Matthiessen's method produced more defined results than the outcomes from Eggin's method. Data from the pilot study pertaining to post-modifying prepositional phrases showed no examples that showed agency or force. However, this analysis will still be explored in the actual study to determine if a larger sample size will produce examples of agency or force-showing prepositional phrases that modify nominalizations. Findings from the pilot study also showed that the metaphorical wording reduced the number of clauses as well as increased the lexical density of the selected text. These outcomes support the implication that nominalizations influence sentence and noun phrase complexity and indicate that the chosen analyses are appropriate for the research.

Verification of Data

Validity

Validity of the current text analysis was considered in three different ways. This study has a high degree of construct validity (McKay, 2006), which means that the tools used do measure what was set out to be studied. The goal of the research is to determine the effects of sentence and noun phrase complexity and all of the above-mentioned instruments do measure elements of sentence and noun phrase complexity. Additionally, internal validity is reflected in the sense that this study is controlled for variables

(McKay, 2006). Although multiple levels of texts will be analyzed, a single genre of science explanations has been chosen with a narrower topic of erosion and weathering. Likewise, only the grammatical feature nominalization will receive concentration. These benchmarks increase the validity of the analysis by reducing the text and topic variations. The external validity of this study, meaning how well the results could be generalized or applied to other contexts (McKay, 2006), is weaker due to the somewhat small sample of texts. This is a result of the size and scope of the research.

Reliability

The current analysis has high intra-rater reliability as the data will be looked at multiple times by the researcher to look for similar results and to decrease human error (McKay, 2006). In addition, there is degree of external reliability to the analysis as it is conceivable that another researcher would meet with similar conclusions if they replicated a comparable study (McKay, 2006). This is especially true since the chosen texts are written by major publishers and are widely available. The presence of a pilot study in the current research also increases the reliability since modifications to the actual study will be made based on the results of the preliminary study. Finally, another researcher will be investigating 10% of the data, which will then be compared with my analysis to verify external inter-rater reliability.

Conclusion

This chapter gave an overview of the research paradigm, the methods and research instruments that will be used for data collection, as well as an overview of the

validity and reliability of the study. Chapter Four will discuss the results of the analysis of five different grade level science texts. Chapter Five will conclude the thesis by examining the findings, and by providing implications for pedagogy.

CHAPTER 4: RESULTS

Seventeen elementary and middle school science textbooks were analyzed to determine the implications of nominalization. Data was gathered to investigate the following questions:

How might nominalization contribute to the sentence structure and noun phrase complexity in first through fifth grade and middle school science textbooks?

- How many examples of nominalization are found in each of the intended levels of texts and what could this indicate?
- Which types of nominalizations are found in each level of science texts and what could this imply?
- How frequently are nominalizations modified by a prepositional phrase that shows agency or force?
- How might nominalization affect the syntax and semantics of the text?
- How might nominalization contribute to lexical density?

This chapter covers results from the text analysis on first grade through middle school science textbook selections. Some general descriptors will be reviewed followed by the results of the occurrence and the types of nominalizations found in the text excerpts. Subsequently, the number of nominalizations modified by a prepositional phrase that shows agency or force will be shared as well as the observations noted from

creating congruent agnates. Finally, the results from the lexical density calculations will be presented followed by the conclusion.

General Descriptors

The texts in the study ranged from 266 words to 1,374 words (Figure 1). They were selected based on the availability of content on the topic of erosion and weathering. The numbers of words in each selection were gathered by counting the available text on the topic of erosion and weathering which included titles, subtitles, and text, but not glossary items, captions, labels, or lesson review boxes. Since the amount of content increased based on the academic level, the word count varied as the grade level increased. The word count also fluctuated within each grade level depending on the amount of information each publisher included on the topic. Because of this varying word count, the percentage of nominalizations in each text was calculated as an alternative for tallying the raw number of nominalizations.

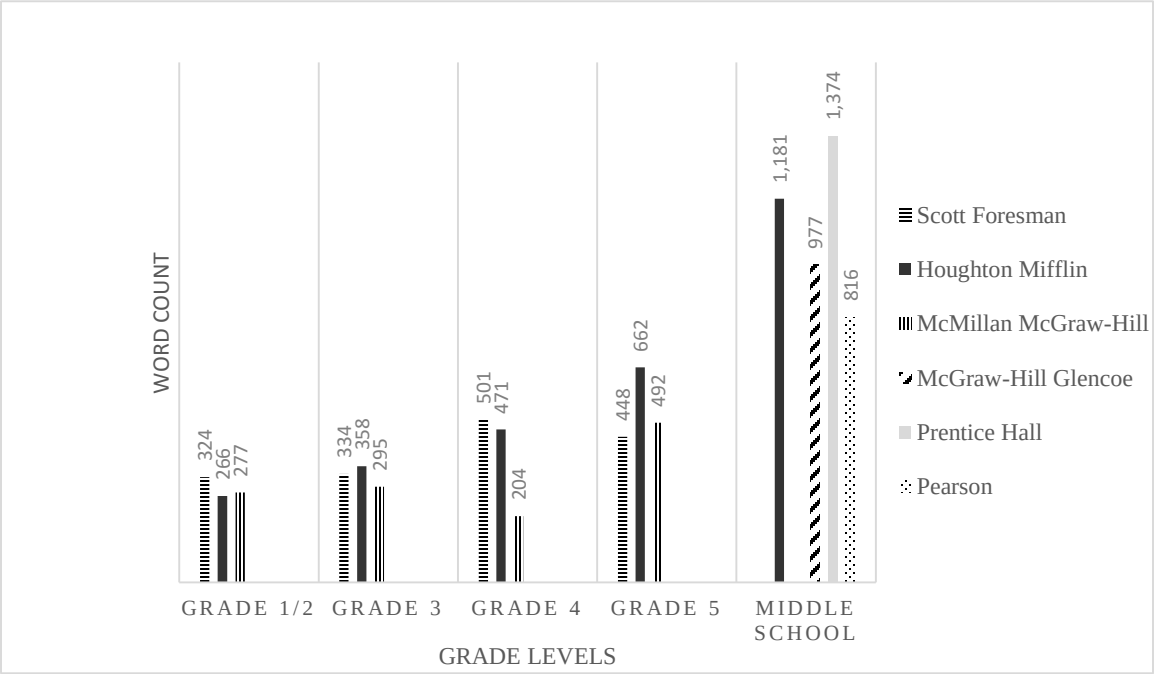

Figure 1. Word count for each level of text by publisher

Occurrence and Types of Nominalizations

The results of counting and categorizing the number of nominalizations varied depending on the text publisher and fluctuated across grade levels as can be seen in Table 13.

Table 13

Nominalization Occurrences

Publisher and Title	Grade Level	# of Words	# of Nom.	% Nom.
Scott Foresman Science	Grades 1-2	324	4	1.2%
Houghton Mifflin Science	Grade 1	266	0	0%
Macmillan McGraw-Hill Science	Grade 1	277	0	0%
Scott Foresman Science	Grade 3	334	16	4.8%
Houghton Mifflin Science: Discovery Works	Grade 3	358	17	4.7%
Macmillan McGraw-Hill Science	Grade 3	294	12	4.1%
Scott Foresman Science	Grade 4	644	32	5.0%
Houghton Mifflin Science	Grade 4	471	23	4.9%
Macmillan McGraw-Hill Science	Grade 4	204	5	2.7%
Scott Foresman Science	Grade 5	448	20	4.5%
Houghton Mifflin Science: Discovery Works	Grade 5	482	16	3.3%
Macmillan McGraw-Hill Science	Grade 5	492	18	3.7%
Earth's Surface (Houghton Mifflin)	Grades 6-8	1,181	49	4.1%
Glencoe Science: Earth Science (McGraw-Hill)	Grades 6-8	977	48	4.9%
Prentice Hall: Earth Science	Grades 6-8	1,374	89	6.5%
Concepts and Challenges: Earth Science (Pearson)	Grades 6-8	816	54	6.6%
Total		8,942	403	4.5%

Nom.=Nominalization #=Number %=Percentage

Table 13 shows the number and percentage of nominalizations in each analyzed text selection as well as the total number and percentage of nominalizations found during the study. Nominalization counts ranged from 0 nominalizations to 89 nominalizations per text with an overall total of 403 nominalizations. This variation is partially due to the difference in word counts of each selection.

As can be seen in Table 13, the range of nominalization percentages spanned from 0% to 6.6%. The original hypothesis projected that as the grade level increased, it would correspond with a progression of nominalization occurrences. Instead, the results fluctuated. As can be seen in Table 14, the middle school texts carried the highest percentage of nominalizations (5.5% nominalizations) and the first and second grade texts contained the lowest percentage of nominalizations (0.5% nominalizations) whereas the third and fourth grade texts possessed similar percentages of nominalizations (4.6% and 4.5% nominalizations, respectively). It is interesting to observe that the third and fourth grade texts averaged a higher percentage of nominalizations than the 3.8% nominalizations in the fifth grade selection (Table 14).

According to Table 13, *Macmillan McGraw-Hill Science: Grade 4* (Daniel, et al., 2005) possessed lower numbers of nominalizations than the other texts in the same grade level. This text had 2.7% nominalizations versus 5.0% and 4.9% in the other fourth grade texts. The fourth grade Macmillan McGraw-Hill textbook had a reduced amount of material on erosion and weathering compared to the other texts in that grade level. In my opinion, the information in this text was presented in a more basic manner as well. This may have led to the discrepant nominalizations results in the fourth grade texts.

Table 14

Grade Level Averages of Nominalization Percentages

Grade Level	Average Percentage of Nominalizations in Selected Texts
1-2	0.5%
3	4.6%
4	4.5%
5	3.8%
6-8	5.5%

Note. Percentages calculated based on the total number of nominalizations divided by the total word count for each grade.

In Table 15, it can be observed that gerunds made up the largest category of nominalizations in ten of the fourteen texts with nominalizations followed by verbs to nouns. Adjectives to nouns clearly made up the smallest category and of these 7 instances, 6 were found in the middle school texts. Underlined illustrations of the various types of nominalizations can be seen in the middle school excerpt from *Teacher's Edition Prentice Hall Earth Science* (Tarbuck & Lutgens, 2006, p. 126) in example (10).

(10) Internal forced gradually raise some parts of the surface through mountain <u>building</u> (gerund) and volcanic <u>activity</u> (adjective to noun). At the same time, external processes continually break rock apart and move the debris to lower <u>elevations</u> (verb to noun).

Table 15

Nominalization Types

Publisher and Title	Grade Level	Gerunds	Verbs to Nouns	Adjectives to Nouns
Scott Foresman Science	Grades 1-2	2	2	0
Houghton Mifflin Science	Grade 1	0	0	0
Macmillan McGraw-Hill Science	Grade 1	0	0	0
Scott Foresman Science	Grade 3	11	5	0
Houghton Mifflin Science: Discovery Works	Grade 3	10	6	1
Macmillan McGraw-Hill Science	Grade 3	6	6	0
Scott Foresman Science	Grade 4	16	16	0
Houghton Mifflin Science	Grade 4	11	12	0
Macmillan McGraw-Hill Science	Grade 4	2	3	0
Scott Foresman Science	Grade 5	12	8	0
Houghton Mifflin Science: Discovery Works	Grade 5	13	3	0
Macmillan McGraw-Hill Science	Grade 5	11	7	0
Earth's Surface (Houghton Mifflin)	Grades 6-8	21	28	0
Glencoe Science: Earth Science (McGraw-Hill)	Grades 6-8	33	14	1
Prentice Hall: Earth Science	Grades 6-8	50	34	5
Concepts and Challenges: Earth Science (Pearson)	Grades 6-8	32	22	0
Total		230	166	7

It should also be noted that during this analysis, non-finite verbs were observed that could easily be mistaken for nominalizations. Although this verb form does indicate

a process and has the same function as a noun because it is the object of a preposition, it is not a nominalization nor is it a noun. For example, in the sentence "The process of breaking down rock is called weathering," although the word *breaking* looks like a gerund, it is really a non-finite verb and the object of the preposition *of*.

Agency and Force-Showing Prepositional Phrase Results

Of the 403 nominalizations found in the various text selections, 8 nominalizations, or 2% of the nominalizations, were modified by an agency or force-showing prepositional phrase that expanded the noun phrase (Table 16). This is a low percentage, but it is consistent with research that states that simple noun phrases can be expanded through the addition of nominalization-modifying prepositional phrases (Fang, Schleppegrell, & Cox, 2006; Biber, et al., 2011).

Table 16

Prepositions that Modify Nominalizations by Grade Level

Grade Level	Prepositions
1-2	0
3	0
4	2
5	1
6-8	5
Total	8

Example (11) from the fourth grade level of *Scott Foresman Science* (Cooney, et al., 2000, p. C46) and example (12) from *Glencoe Science Earth Science* (Feather, et al., 2008, p. 184) show illustrations of these types of prepositional phrases.

(11) The **moving** of weathered rocks and soil by water, wind, and ice is erosion.

(12) Mechanical **weathering** by plants, animals, and ice wedging reduces rocks to smaller pieces.

The bolded nominalizations are modified by the underlined prepositional phrases. It is interesting to observe that both of these examples include multiple agents or forces in the prepositional phrase (*water, wind, and ice* or *plants, animals, and ice wedging*) and that one of the forces in example (12) is a nominalization (*wedging*).

More than half of all the nominalization-modifying prepositional phrases in the text selections occurred in the middle school texts. No agency or force-showing prepositional phrases appeared in the first, second, or third grade texts. It is interesting to note that the agency or force-showing prepositional phrase results are similar to the nominalization occurrence data. For example, the middle school texts had both the highest percentage of nominalizations in the occurrence data (texts possessed 5.5% nominalizations) and the highest number of prepositional phrases (5 out of 8) according to Table 16. Similarly, the fourth and fifth grade texts followed with 4.5% and 3.8% nominalizations and 2 out of 8 and 1 out of 8 agency or force-showing prepositional phrases.

It should also be noted that during this analysis, several examples of implied force were observed that could be mistaken for agents. For example, when the metaphorical sentence (13) is turned into a congruent agnate (14), it could appear that *rocks* are the doers.

(13) Weathering is the breaking down and the changing of rocks.

(14) Rocks break down and change when they are weathered.

However, some entity or force must cause the weathered rocks to break down and change. This force is not mentioned in the sentence; it is only assumed. Therefore, this is an example of implied force rather than agency or force.

Congruent Agnate Results

Of the 23 analyzed sentences in the selected texts, 17 sentences experienced a clause count increase when the wording was changed from metaphorical to congruent wording (Table 18). This is consistent with the research, which reveals that lexically dense sentences have only one or two clauses that are each crammed with meaning (Derewianka, 1990).

Table 18

Number of Clauses in Each Metaphorically or Congruently Worded Sentence

Grade Level	Grade 1		Grade 3		Grade 4		Grade 5		Grade 6-8	
Sentence #	M	C	M	C	M	C	M	C	M	C
1	1	2	1	1	1	3	2	2	1	3
2	1	1	1	2	1	2	1	2	2	2
3	1	2	1	2	1	2	3	4	1	3
4	N/A	N/A	1	2	1	1	2	3	1	2
5	N/A	N/A	1	2	2	3	1	2	1	1

#= Number M=Metaphorical Wording C=Congruent Wording

As can be seen in Table 19, almost no change was noted between the number of metaphorical clauses and the number of congruent clauses in the first grade selection. However, similar clause count differences of 4 or 5 were noted for the rest of the grade levels. Nonetheless, the number of clauses increased in every instance once the metaphorical wording was changed to congruent wording. An illustration of this clause difference can be seen in a metaphorical example (15) and a congruent example (16) from the fourth grade text, *Scott Foresman Science* (Cooney, et al., 2000, p. C44). The number of clauses, which are indicated using brackets, increases from one clause in example (15) to two clauses in example (16).

(15) [The freezing and melting over and over again breaks the rocks apart].

(16) [The rocks break apart [as they freeze and melt over and over again]].

Table 19

Clause Count

Grade Level	Number of Clauses in Metaphorical Wording	Number of Clauses in Congruent Wording	Difference
1	3	4	1
3	5	9	4
4	6	11	5
5	9	13	4
6-8	5	10	5

Lexical Density Results

The results from the lexical density calculations of the congruent agnates show that the metaphorical wording had a higher lexical density calculation than the congruent wording (Table 20). These results are consistent with the research which states that nominalizations contribute to lexical density by condensing an entire process into one word (Kazemian, et al., 2013).

Table 20

Lexical Density Differences for Metaphorical and Congruent Wording

Grade Level	Metaphorical	Congruent	Difference
1	4.0	3.5	0.5
3	6.4	4.2	2.2
4	6.2	3.5	2.7
5	4.1	3.1	1.0
6-8	9.4	5.1	4.3

The noted increase of lexical density in the metaphorical versions may be due in part to the inclusion of post-modifying prepositional phrases after nominalizations as noted in the earlier-mentioned analysis. This would be consistent with the research stating that lexical density occurs as noun phrases lengthen through the inclusion of pre-modifiers before the noun and post-modifiers after the noun to pack more information into each clause (Fang, 2006; Fang & Schleppegrell, 2008).

The greatest lexical density difference between the metaphorical and congruent wording existed in the middle school versions followed in order by the third, fourth, fifth, and first grade versions. It is interesting to note that this progression roughly corresponds with the averages of nominalization percentages by grade level. That is, the nominalization occurrence data showed that middle school texts had the highest percentage of nominalizations followed by the third grade texts, then the fourth grade texts, after that, the fifth grade texts and finally the first and second grade texts. A similar pattern can be seen in the metaphorical lexical density calculations as well as in the calculations showing the difference between the metaphorical and congruent lexical

density. The middle school text has the highest lexical density and the greatest difference between the metaphorical and congruent lexical density followed by the third grade text, then the fifth grade text, and finally the first grade text. The fourth grade text does not fit the pattern as it shows a higher lexical density difference than the third grade text. It is surprising to observe the similarity between both first grade and fifth grade lexical density calculations since it would be expected that the fifth grade lexical density would be higher than the first grade lexical density.

An example of how lexical density was calculated can be seen in example (17) for the metaphorical wording and in example (18) for the congruent wording from the third grade text, *Scott Foresman Science* (Cooney, et al., 2000, C20-C21). Brackets indicate individual clauses and font features correspond with the parts of speech tallied in the lexical density calculation in Table 21.

Table 21

Halliday's Lexical Density Calculation: Grade Three

	Metaphorical Paragraph	**Congruent Paragraph**
NOUNS/PRONOUNS	17	16
Verbs	6	12
Adjectives	4	4
Adverbs	4	5
Total Content Words	31	37
Total Clauses	5	9
Lexical Density	**31/5=6.2**	**37/9=4.1**

(17) Metaphorical Wording for 3rd Grade Text

[WEATHERING is usually a *slow* CHANGE.] [WEATHERING is the BREAKING down and CHANGING of ROCKS.] [WEATHERING can be caused by WATER, *changing* TEMPERATURES, and *living* THINGS.] [After many YEARS of WEATHERING, a *huge* BOULDER might crack and crumble.] [The TOPS and SIDES of MOUNTAINS can also be changed by WEATHERING.]

(18) Congruent Wording for 3rd Grade Text

[ROCKS usually weather and change slowly.]] [ROCKS break down and change [as THEY weather.]] [ROCKS weather for many REASONS.] [WATER, *changing* TEMPERATURES, and *living* THINGS are *some* of the CAUSES.] [A *huge* BOULDER might crack and crumble [after IT weathers for many YEARS.]] [The TOPS and SIDES of MOUNTAINS can also change [as THEY weather.]]

Conclusion

In Chapter Four, the results from the data collection confirmed that nominalizations are located within elementary and middle school science texts. In all, 403 nominalizations were located. The highest percentage of nominalizations was found in the middle school texts with 5.5%. Three types of nominalizations were tracked including gerunds, verbs to nouns, and adjectives to nouns with gerunds being the most prevalent at 230 out of 403 nominalizations. Of all the noted nominalization-modifying prepositional phrases 42 showed agency or force. The data revealed that an increase in the clause count occurred when the metaphorical wording was changed to a congruent

wording. All the grade levels increased by 4 or 5 clauses through the creation of a congruent agnate except for first grade which only increased by 1 clause. The data also determined that a higher lexical density occurred for the metaphorical wording than for the congruent wording. At 4.3, the middle school text showed the greatest difference in lexical density between the metaphorical and congruent versions.

In Chapter Five, the major findings will be re-identified and the limitations of the study will be discussed. Implications for teaching as well as suggestions for research beyond the scope of this research will also be introduced. Additionally, Chapter Five will include information on how the results will be disseminated along with personal reflections on the participation in the study.

CHAPTER 5: CONCLUSION

During the current text analysis the following questions guided the research: *How might nominalization contribute to the sentence structure and noun phrase complexity in first through fifth grade and middle school science textbooks?*

- How many examples of nominalization are found in each of the intended levels of texts and what could this indicate?
- Which types of nominalizations are found in each level of science texts and what could this imply?
- How frequently are nominalizations modified by a prepositional phrase that shows agency or force?
- How might nominalization affect the syntax and semantics of the text?
- How might nominalization contribute to lexical density?

Major Findings and Connections to Prior Research

The first goal of this research was to determine the number of nominalizations present in various levels of elementary and middle school science texts and to posit what these occurrences could indicate. Prior research states that the language of science contains abstractions which include nominalizations (Christie, 2002; 2012; Derewianka, 1992; Fang, 2004; 2008; Fang, Lamme, & Pringle, 2010; Fang & Schleppegrell, 2008; Halliday & Martin, 1996). The current study confirmed prior research since a total of

403 nominalizations were found in an 8,942-word corpus, which means that 4.5% of the words in the sample texts were nominalizations. Fifteen of the 17 analyzed texts possessed nominalizations since two of the first grade texts did not contain any examples of this grammatical feature. The highest percentage of nominalizations was found in the middle school texts, with nominalizations making up an average of 5.5% of the words. Previous research determines that children are liable to encounter grammatical metaphors, of which nominalizations are one example, in upper elementary school (Halliday & Matthiessen, 2014). This claim is consistent with the current study since the fourth and fifth grade texts contained 4.5% and 3.8% nominalizations, respectively. However, Halliday and Matthiessen's claim is inconsistent with the findings in the first through third grade texts. Although the first and second grade texts contained the lowest percentage of nominalizations in the study (0.5% were nominalizations), nominalizations were still present in this primary level. Furthermore, 4.6% of the words in the third grade texts were nominalizations, a higher percentage than either the fourth or fifth grade figures. This data may indicate that nominalizations become commonly used in science texts beginning in third grade and increase in use in middle school texts. However, more research would be needed in order to verify this claim. The idea that nominalizations are common in science texts as early as third grade is concerning, however, considering that research has revealed that children may not be able to comprehend more metaphorical modes of expression including nominalizations, until age nine or ten (Halliday & Matthiessen, 2014). This notion will be explored more thoroughly in the implications section of this chapter.

Previous research also states that even in elementary or middle school science texts, the use of certain conventions, like abstractions, cannot be avoided (Fang, Lamme, & Pringle, 2010). This may explain why nominalizations were found in texts as early as first and second grade. For instance, in example (19) from the second grade text, *Scott Foresman Science* (Cooney, et al., 2000, p. C12), it is possible that the underlined nominalization *erosion* would be used in a second grade text because it is difficult to mention the bolded explanation of erosion over and over again in its verb form. Therefore, nominalizations may be unavoidable since they make the text more compact.

(19) **When soil or rock are carried away by water, wind, or other rocks**, it is called <u>erosion</u>.

Additionally, certain processes may also be necessary to incorporate into texts because they are included in state-required standards. For instance, Minnesota state standards requires that second grade students must demonstrate an ability to measure, record and describe temperature and precipitation (Minnesota Department of Education, 2010). For this reason, the use of the word *precipitation* would be obligatory in second grade science materials.

Another objective of this study was to identify which types of nominalizations were found in each level of science text and to determine any implications of these findings. Although researchers have indicated that various types of nominalizations exist (Hartnett, 1998; Humphrey, et al., 2012; Rodby & Winterowd, 2005), no previous research analyzing the prevalence of various types of nominalizations was found.

Therefore, through this current study, it was determined that of the three types of tallied nominalizations including gerunds, verbs to nouns, and adjectives to nouns, gerunds occurred most commonly with 230 instances out of 403 nominalizations. This could suggest that gerunds are more commonly used to explain the topic of erosion and weathering. Or, it could mean that there are more gerunds possible than the other types of nominalizations. Nevertheless, since nominalizations are generally treated as one large category in research, a closer look at each type of nominalizations would provide a rewarding area for future investigation.

Previous research states that nominalizations provide the opportunity for more information to be packed into each clause through the extension of noun phrases which allow a sentence to carry more content (Eggins, 2004; Derewianka, 1990). Since an addition to a simple noun phrase often occurs by adding a post-modifying prepositional phrase to a nominalization (Fang, Schleppegrell, & Cox, 2006; Biber, et al., 2011), the current study was designed to determine how frequently nominalizations are modified by a prepositional phrase that shows agency or force. Of 403 nominalizations in the data, only 8 nominalizations had post-modifying prepositional phrases that showed agency or force which means that 2% of the nominalizations in the text were part of noun phrases that experienced expansion through the addition of post-modifying prepositional phrases. This is a smaller number of instances than was expected. It is possible that so few occurrences of prepositional phrases that showed agency or force following a nominalization were found because science texts simply do not lend themselves to agency. This may be due to the fact that passive voice is often used to emphasize

processes and to omit the actor or agent (Fang, 2006). Or, it may be that a force is less obvious in texts about nature which involve inanimate participants. That is, a force may still be involved, but because of the passivation, the agent is removed and the force is not stated, just implied. On the other hand, prior research asserts that a noun phrase becomes increasingly more complex each time more information is inserted into the phrase (Fang, Schleppegrell, & Cox, 2006; Biber et al., 2011). Previous studies also reveal that nominalizations contribute to text complexity (Schleppegrell, 2010; Halliday & Martin, 1996). Thus, because the definition of noun phrase complexity for this research taken from Biber et al. (2011) states that additions to a noun phrases adds to increased sentence complexity, the findings in this study shed light on how nominalizations might contribute to noun phrase complexity. That is, a small number of nominalizations in this data were post-modified by an agency or force-showing prepositional phrase. Thus, nominalizations may contribute to noun phrase complexity based on the earlier-mentioned definition of noun phrase complexity in conjunction with the findings from this study. More research, however, would need to be conducted to see if these conclusions hold true across a wider scope of genres or topics and text samples.

Another goal of this research was to determine how nominalization might change the syntax and semantics of the text. Previous research conducted by Thompson (1996) states that nominalizations condense information that could be communicated in an entire clause down to a word or group, therefore changing the syntax. Congruent agnates were also created in order to determine how nominalizations affect the syntax of a text. The data from the creation of these agnates established that there was an increase in the clause

count when the metaphorical wording was changed to a congruent wording. All the grade levels increased by 4 or 5 clauses except for first grade which only increased by 1 clause. An illustration of this increase can be seen in examples (19) and (20) from a fifth grade sample of the current data. The text from example (19) is taken from *Scott Foresman Science* (Cooney, et al., 2000, p. C21). Example (19) displays the metaphorical version of the text whereas example (20) shows the congruent version. The brackets demonstrate where the clause breaks appear.

(19) [Chemical weathering changes the substance [that makes up rock]].

(20) [The substance [that makes up rock] changes [as it is chemically weathered]].

Not only does the syntax change from example (19) to example (20), but the rearranging of words also requires a clause increase from 2 tensed clauses in example (19) to 3 tensed clauses in example (20). Although additional investigation would be needed to confirm the results, the results from this analysis are consistent with Thompson's research and indicates that nominalizations do influence the way words are put together in a sentence or in a clause.

Earlier research acknowledges that as a result of nominalizations, the semantics of a text also change (Martin, 1996). Although careful attention was given during the current study to ensure that the overall message of each sentence was maintained through the creation of agnates, nominalizations, by nature, shift the grammar. This change occurs because through nominalization a congruent verb process or an adjective

description become metaphorical nouns, which affects their semantic meaning. Accordingly, data from the congruent agnate analysis in the current study shows semantic change. To illustrate, the congruent example (20) shows *weathered* as a verb, but example (19) shows *weathering* in a nominalized form. These two words have similar meanings, but in reality, the metaphorical nominalization *weathering* actually has two layers of meaning (Halliday and Matthiessen, 2014). Not only does it semantically mean a thing (*weathering*), but also a process (the congruent meaning *to weather*).

Previous research also asserts that lexical density is a result of grammatical metaphor (Kazemian & Hashemi, 2014; Kazemian, et al., 2013). In order to explore this claim in the current study, the number of content words from text selections was divided by the number of clauses in both the metaphorical and the congruent versions to determine how nominalization might contribute to lexical density. The data revealed that in all the grade level texts, a higher lexical density occurred for the nominalization-containing metaphorical wording than for the congruent wording. The greatest lexical density difference between the metaphorical and congruent versions was found in the middle school text at 4.3. The first grade text showed the lowest difference at 0.5 although an increase was still noted when comparing the congruent to the metaphorical version. This noted increase in lexical density corresponds with the conclusions from earlier studies by Kazemian, et al. (2013) and Kazemian & Hashemi (2014) since the data shows that the versions containing nominalizations were calculated at a higher lexical density. In addition, previously found research proclaims that lexical density occurs as a result of lengthened noun phrases through the addition of pre- and post-modifiers which

include prepositional phrases (Fang & Schleppegrell, 2008). This causes an increase in complexity as more information is packed into each clause (Fang, 2006). A connection between this lexical density analysis and the previous analysis on post-modifying prepositions phrases can be seen. That is, nominalizations may contribute to lexical density because, as nominalizations are used, nominalization-modifying prepositional phrases are able to follow which simultaneously increase the lexical density. This claim, however, would need to be verified through additional research.

Limitations

Due to the scope of this study, a few limitations were present. The principal limitation was the small sample of texts. Although selections from six major publishers were used, in order to increase the strength of the study, more texts could have been investigated. A larger corpus could have provided more evidence to support the conclusions of the analysis. This study was also limited to science explanations, which is just one of many science genres. With a broader scope of investigation, additional genres could have been analyzed to produce more generalized results. Similarly, only the specific topic of erosion and weathering was considered, which limited the length of each text. Since the subjects *erosion* and *weathering* are nominalizations themselves, it is possible that these topics produced an increased number of nominalizations compared to other earth science topics. Thus, by expanding the topic to include content other than erosion and weathering, it is possible that different results could have been produced. Additionally, if the scope of content was increased beyond the topic of erosion and weathering, the length of passages from each textbook could thereby have been

increased, providing a larger sample size of text. This study was also limited to only three types of nominalizations: gerunds, verbs to nouns, and adjectives to nouns. Expanding the types of nominalizations to include nouns and verbs spelled alike could further alter the results. Finally, while 10% of the data was checked by another researcher for inter-rater reliability, including multiple researchers in the data analysis process could have improved the reliability of the study and minimized the error margin.

Further Research

Suggestions for further research provide a response to the limitations of the study. In order to generalize the results of the research more comprehensively, a larger sample size of texts should be considered. This could possibly contain genres of science texts other than explanations such as reports, narrative expository, or how-tos. Or, the type of text could be expanded to include lab reports, workbooks, science trade books, graphs, charts, and maps, or captions. Future research could also incorporate texts from other academic disciplines beyond science such as social studies textbooks. Moreover, the results from two diverse academic subjects could be compared to determine how nominalizations affect genres in a similar or dissimilar manner. An expanded comparative study could also broaden the research to take account of high school texts in addition to the elementary and middle school texts. Additionally, since there were so few occurrences of prepositional phrases that showed agency following a nominalization in the data for this current research, it is possible that a genre other than science explanations would provide different results. Specifically, because science texts generally omit human participants, agency is not as common. Therefore, a future study

could analyze another subject area such as social studies, which more frequently discusses human actors, to determine the prevalence of agency-showing prepositional phrases. To continue investigations conducted by Halliday and Matthiessen (2014) which state that some children are able not to comprehend nominalizations until age nine or ten, additional research could also study how nominalization affects comprehension. Specifically, at various grade levels, reading materials could be presented in either metaphorical or a congruent forms to determine how the two presentations affect students' comprehension. Lastly, further research could also study additional types of nominalizations such as nouns and verbs spelled alike or investigate non-finite verbs which are similar in appearance to gerunds.

Implications for Teaching

Based on the results of the data from the current study, a number of teaching implications can be considered. With nominalizations consisting of 4.5% of all the words in the text selections for this study, a first important implication emerges for teachers to familiarize themselves with the linguistic feature of nominalizations. Prior research shows that, often, teachers do not explicitly teach language features because they are unaware that these features exist (DeJong & Harper, 2005; Cameron, 2011). Furthermore, educators often don't realize that their lesson content may be compromised by a limited understanding of certain language features such as nominalizations (Cameron, 2011). Therefore, an increased teacher awareness of what a subject area, such as science, linguistically demands would help teachers know where to begin before instructing the academic content (DeJong & Harper, 2005). This could be done through a

text analysis using tools similar to the ones utilized in the current study. Or, it could resemble research conducted by Cameron (2011), which demonstrates how EL teachers can learn about nominalizations found in academic texts. In this study, Cameron surveyed teachers to determine their prior knowledge about nominalizations and then delivered model lessons on how to recognize nominalizations, how to deconstruct nominalizations back to their original part of speech, and how to write their own texts using nominalizations. Through this study, Cameron realized that if teachers could comprehend the concept of nominalizations more easily, then they could teach nominalizations to their students. This notion is supported by Schleppegrell (2001), who states that teachers should identify the grammatical expectations of a language task in order to understand the challenges that academic texts may pose for students. Thus, a vital implication of this study is that teachers understand how nominalizations exist in a text as well as to recognize why nominalizations are important to teach.

The fact that nominalizations consisted of 4.5% of all the words in the text selections from this study also implies that explicit teaching about nominalizations may be necessary. Research states that in order to access lexically dense, abstract texts, students benefit from being taught the particular grammatical forms and discipline-specific language present in the texts they encounter (Anstrom & DiCerbo, 2011; Cameron, 2011; Fang & Schleppegrell, 2008). In the context of this research, these specific grammatical forms would be nominalizations. Additional research on the most effective ways to teach nominalizations in a scaffolded manner has been conducted by various authors who have provided strategies to make nominalizations more transparent

to learners including Fang, Lamme, and Pringle, 2010 and Schleppegrell, 2010. Before anything else, research suggests that students' awareness about the role of nominalization in science texts should be raised (Fang & Schleppegrell, 2008) which can then be followed by activities designed to interact with this grammar feature. The study by Cameron (2011), which was mentioned earlier, gives recommendations for teaching nominalizations. One of the recommendations includes using a table of common nominalization endings and challenging students to find nominalizations with similar endings in a selected text. This activity could be followed by having students find the processes in each clause (Humphrey, et al., 2012) or by allowing students to identify the verbs or adjectives from which various nominalizations may have originated. Learners could box in subjects, underline verbs, or write infinitive verb stems close to the nominalizations (Cameron, 2011).

Additionally, tools used in the current study, such as creating congruent agnates, could also be utilized in the classroom to unpack dense scientific writing caused by nominalizations (Berg, 2011). Because students may fail to notice processes behind the nominalized participants, with support and modeling by the teacher, the method of unpacking the nominalizations could alter the syntax of the sentences to make the abstract texts more transparent to learners (Humphrey, et al., 2012; Fang, 2008). Teachers could also interact with academic texts using other tools based on the SFL approach such as a process/participant analysis (Schleppegrel, 2010). This tool might be useful to discuss the constituents of a clause and to attach meaning-oriented labels to each part of a clause structure. As utilized in the current study, if a process/participant

analysis is used in conjunction with congruent agnates, it may provide a way for students access the semantics of a text to see how nominalizations alter processes to become participants. A tool like this could help educators teach 'through language and teach about language' (Schleppegrell, 2010, p. 91). In doing so, a link could be developed between language and meaning so that students realize how various science features work to construct meaning in a text. Depending on the proficiency level of students, after they are comfortable identifying and creating nominalizations or unpacking the meaning of nominalizations, they could apply their newfound knowledge by creating original sentences using nominalizations (Cameron, 2011).

Even though only 2% of nominalizations from the selected texts were part of noun phrases that experienced expansion through the addition of post-modifying prepositional phrases, educators might consider teaching their students how to unpack these noun phrases. Since science texts often involve topics of cause and effect, students need to find the forces or agents which cause an action even if they are buried in a nominalization-modifying prepositional phrase. Because congruent versions of text more clearly state the force or the agent of a sentence, teachers could use congruent agnates to unpack complex noun phrases with nominalizations. This could recover the agency or force so that it is not concealed in a post-modifying prepositional phrase (Fang & Schleppegrell, 2008). Another analysis, called noun deconstruction, provides a different way of unpacking noun phrases which allows the analysis of an extended noun phrase by distinguishing the different components of its structure (Fang, 2008; Fang, Lamme, & Pringle, 2010; Fang & Schleppegrell, 2008). For example, a complex noun phrase could

be broken down into pre-modifier, head noun, and post-modifier parts to make the components easier to interpret (Fang & Schelppegrell, 2008).

Finally, based on the results from the study which show that nominalizations begin appearing in science textbooks as early as first grade, teachers should consider teaching students about nominalizations in the primary and middle school grades. The average percentage of nominalizations in first and second grade texts was only 0.5%, which may not warrant the need to explicitly teach this grammar element as early as first grade. However, because nominalizations do exist in first and second grade texts, teachers may want to think about explaining this more involved wording to younger students. This could be done by moving back and forth between congruent and metaphorical wording to show students how they are equivalent ways of saying the same things. Or, to accommodate a younger audience, texts may be rewritten to make the content of a nominalizations more transparent (Fang & Schleppegrell, 2008).

Nevertheless, with nominalizations consisting of as much as 4.8% of third grade texts, a percentage which is equal to or greater than the texts in higher grade levels, explicit teaching beginning in third grade should be considered. Still, previous research stating that children are not able to comprehend grammatical metaphors until about nine to ten years of age (Halliday, 1985) should also be contemplated, given that it is possible students in third grade may not possess the ability to grasp the concept of nominalizations. In spite of all this, since nearly 7% of all the words in the middle school texts selected for this study were nominalizations, I suggest that nominalizations be included in the educational curriculum for both mainstream students and especially for

ELs. It should be mentioned that even though teaching implications have been mentioned in this study based on the prevalence of nominalizations found in the current investigation, further research is still needed to determine the effects of instructing nominalizations to ELs.

Dissemination of Results

There are several ways in which I plan to disseminate the findings of the present study. During my current work, I supervise student teachers through review of their lesson plans and by observing and evaluating the teaching candidates' lessons. One of our ongoing goals includes developing and implementing differentiated lesson plans to include ELs using both content and language objectives. Therefore, the data from this study will inform my conversations with pre-service teachers about the importance of looking at various textual features to inform teaching goals, to be alert that certain textual features, specifically nominalizations, are present in elementary texts even as early as 1st grade, and to encourage student teachers to explicitly teach nominalizations to their students in the science classrooms.

Secondly, I believe existing educators should be privy to the prevalence of nominalizations and the implications to the frequency of nominalizations in elementary and middle school texts. Consequently, I plan to present the findings of my capstone research at the Minnesota English Learner Education Conference. My message will focus on the importance of teaching nominalizations. I also hope to convey the value of engaging in text analysis research to inform teachers about what language features should be taught alongside various content lessons.

Finally, I plan to contact the publishers of the first through third grade science texts that I analyzed. Based on previous research which says that children are not able to comprehend grammatical metaphors until about nine to ten years of age (Halliday, 1985), I find it concerning that nominalizations are included in the texts at such young levels. Therefore, I plan to inquire about publishers' knowledge about nominalizations and to ask what their approach is regarding the use of nominalizations in their textbooks.

Personal Reflection

Through the process of this text analysis, I have learned some valuable lessons. I have always felt strongly about teaching grammar explicitly to students even at a very young age. This study, however, gave me new eyes to see a grammar form that had seemed too complex and too difficult to understand on my own let alone to teach to students. However, through the investigation, it became obvious to me that teaching nominalizations to students is absolutely necessary. Since I am a native English speaker, I can't remember learning about most grammar features because they weren't difficult for me to grasp. Or, they have been a part of my vernacular and so are not obvious teaching points to students. However, I now realize that there are probably a whole host of other types of grammar features that I need to discover and that I need to teach to my students to make text accessible. After practicing the analyses in this study and after observing how even one grammar feature can affect the complexity of a text, I feel like I have the confidence and the obligation to analyze texts that I plan on presenting to students. This way I will be able to determine and teach the grammatical features that may cause comprehension difficulties.

Beyond the classroom, I have a passion for curriculum writing and would love to embed elements gleaned from this study into curriculum I write in the future. I hope that through the marriage of language features and academic content, students can be provided with the information they need to comprehend school texts. I also have a desire to teach at the post-secondary level in the future. Through this aspiration, I aspire to pass along the findings from the current research as well as instill in others a passion to delve into the intricacies of language features so language learners can be provided with the tools they need to confidently access academic texts.

Final Reflections

Through this study, insights were gleaned on the possible contribution of nominalizations to noun phrase and sentence structure complexity of elementary and middle school science texts. It was established that several types of nominalizations are present in varying amounts in first through eighth grade science textbooks. These occurrences along with post-modifying prepositional phrase that show agency or may indicate an increase in lexical density and may influence the syntax and semantics of texts. While this study was limited by the sample size of texts and only explored three types of nominalizations, a number of teaching implications were still identified. These suggestions included teachers familiarizing themselves with the linguistic feature of nominalizations, explicitly teaching students about nominalizations, utilizing tools presented in the current study such as congruent agnates, teaching students how to unpack noun phrases by distinguishing the different components of its structure, and beginning nominalization instruction in the primary grades. Overall, this study presented

information on nominalizations with the hope that more ELs can be taught in a way that helps them comprehend academic texts so they can be more effectively introduced to the world of science.

APPENDIX

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