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The purpose of this study was to document evidence of evolving disciplinary literacy in adolescents by examining 9th and 11th grade students' ability to shift writing styles for different disciplines. It was hypothesized that different language measures would be associated with the specific discipline areas of English Language Arts (ELA), science, and history.

Two groups of typically developing adolescents in 9th and 11th grade (n=22 per group) were asked to write three essays in response to prompts based on course content (ELA, science, and history). Essays were examined for measures of productivity, lexical elements, and clauses.

As predicted, 11th grade students used longer noun phrases and more lexically complex words in science writings and used more adverbial clauses in history writings. Students in both 9th and 11th grade used more nominal clauses and more clausally complex sentences in ELA writings. However, no differences were found in content writing for length of Mean Length of T-Unit (MLT-U), abstract nouns, or adverbial clauses.

The use of cohesive words and phrases did not increase between 9th and 11th grade. Relative clause use increased from 9th to 11th grade in ELA writings. The use of conjoined clauses remained stable between grades for all three content areas and the use of infinitive clauses remained stable in science.

This research reflects the fact that high school students are beginning to acquire knowledge about disciplinary literacy as they are applying some identifiable language elements to each discipline.

ADOLESCENT WRITING IN THE CONTENT AREAS

by

Carrie Knight

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Approved by

_____
Committee Chair

To Jack, Hannah, and Andrew

APPROVAL PAGE

This dissertation written by Carrie Knight has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

Committee Chair _____

Committee Members _____

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_____
Date of Acceptance by Committee

_____
Date of Final Oral Examination

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CHAPTER I

STATEMENT OF THE PROBLEM

Basic reading skills are not adequate enough for the information based technology and workplace demands of the 21st century. Students need to have the skills necessary to access, interpret, critique, and produce oral and written texts on paper and electronically. They also need to exhibit these skills in specific subject areas and disciplines. High school students are beginning to acquire some knowledge about disciplinary literacy (Fang, 2012; Moje, 2007; Shanahan & Shanahan, 2012b). There is currently no research, however, that has examined high school student's developing ability to vary their language use when writing texts for different disciplines. The purpose of the present study is to fill this gap in the literature by comparing 9th and 11th grade students' written texts in science, history, and language arts.

In the past 10 years or so, much has been learned about disciplinary literacy. Aspects of disciplinary literacy that have been investigated include (a) specifying the reasoning and thinking skills members of a discipline use to comprehend or produce oral and written texts, (b) identifying the specific linguistic differences in texts, and (c) determining the best way to teach these skills to students (Moje, 2007). The current study will focus on identifying the specific linguistic differences in student-generated texts.

In high school, students are required to write for different disciplines. For example, in science classes such as biology or chemistry students will have to write an expository text in the sub-genre of a lab or experimental report (Kiuhara, Graham, Hawken, 2009; Shanahan, 2012b). In history classes, students may have to write an expository text in the sub-genre of a summary of historical events, papers that compare different interpretations of historical events (e.g., causes of WWI, Vietnam War, etc.), or biographies of historical figures (Coffin, 1997; Kiuhara, Graham, Hawken, 2009: Monte-Sano, 2010). In English Language Arts classes, students will write expository texts in which they relate events in a novel to their own lives and, like history, papers that compare different interpretations of texts (Kiuhara, Graham, Hawken, 2009).

Disciplinary discourses use distinct linguistic patterns that enable experts to conduct their work (Fang, 2012: Scheleppegrell, 2004). For example, scientists construe explanations about the natural world through nominal syntax (e.g. "The mutually exclusive splicing of one of these exonic sequence clusters," (Fang, 2012, p. 25) and technical vocabulary (e.g. polymorphism, ribonucleic acid, mutation) (Halliday & Martin, 1993). Historians use abstract language (e.g. attitudes, decisions, racist) and long noun phrases (e.g. "the 1954 Supreme Court decision Brown v. Board of Education of Topeka" (p. *29*, Fang, 2012) to move from chronological retelling of the past to a biased interpretation of events, ideas, and institutions (Coffin, 1997; Coffin, 2006; Monte-Sano, 2010; Scheleppegrell, 2004). Writers in English Language Arts (ELA) use longer sentences as they link together clauses through coordination and subornation and use abstract nouns to describe characters feelings, actions, dialogues, and thoughts (Fang,

2012; Schleppegrell, 2004). These linguistic distinctions reflect the fundamental differences in the ways that content experts express their work however, this previous research is solely in the readings that adolescents must do.

As indicated above, no known studies have reported high students' developing ability to use different language structures and forms in written texts for different disciplines. Studies that have examined adolescent writing have tended to focus on specific genres such as persuasive writing (e.g. Crossley, Weston, McLain-Sullivan & MacNamara, 2011; Nippold et al., 2005). These studies found age related changes in essay length, mean length of utterance, noun modifiers, abstract nouns, and metacognitive verbs. Age-related changes in adverbial conjuncts and discourse cohesion were conflicting. Nippold et al. (2005) found increases in use of adverbial conjuncts whereas Crossley and McNamara (2010) found no change.

Taken together, the findings of these studies demonstrate the need to further examine the language characteristics of adolescent writing in different disciplines. The current study will compare samples of 9^{th} and 11^{th} grade student writing in history, science and ELA. Specific aspects of language that will be analyzed include technical vocabulary, lexical vocabulary, cohesive words and phrases, abstract noun, lexical complexity, nominal clauses, adverbial clauses and sentence length. Specific research questions and hypotheses are presented after the literature review.

CHAPTER II

REVIEW OF THE LITERATURE

Basic reading and writing skills in the content areas are no longer considered adequate to be competitive in today's marketplace. Until recently, content area literacy has been the focus in high schools. Content area literacy is defined as the "ability to use reading and writing effectively as tools for thinking about and learning from texts across different subjects" (Fang, 2012, p. 19). The belief is that the cognitive requirements of reading and learning from texts are the same regardless the subject content areas and that a primary difference between school subjects is in their content (Shanahan & Shanahan, 2012a). As a result, content area literacy focuses on basic reading skills (e.g. decoding, fluency, vocabulary), generic strategies (e.g. mapping, note taking), and cognitive text processing strategies (e.g. summarizing, questioning, predicting) (Fang, 2012). These skills and strategies are believed to assist students in gathering information from any content area text to learn and retain the content in school subjects.

Disciplinary literacy refers to the knowledge and abilities to engage in social, semiotic, and cognitive practices consistent with those of content experts who create, communicated and use knowledge within the disciplines (Shanahan & Shanahan, 2012a). The belief is that reading and writing are fundamental to specific disciplinary practices and that disciplines differ in content and the ways the content is

produced, communicated and critiqued (Fang, 2012). Through this belief, literacy is the core to disciplinary enculturation and socialization (Moje, 2008) and not just a set of strategies to be imported into the disciplines to improve reading and writing of texts across content areas (Fang, 2012). General strategies such as activating prior knowledge, questioning, and summarizing can be broadly applied to a range of tasks through the disciplines (Jetton & Shanahan, 2012). However, they are not considered enough. Each discipline has specific ways of organizing "vast bodies of related knowledge and experience" (Jetton & Shanahan, 2012, p. x). For example, a student in ELA needs to understand that the author uses the death of the bird in "The Scarlet Ibis" (Hurst, 2000) to foreshadow the death of one of the main characters. The student needs to analyze the text for the use of foreshadowing and that strategy is not transferable to another discipline such as science or math.

The move toward a discipline specific approach to literacy learning reflects the increased understanding that literacy practices vary across disciplines. Disciplines differ in how they produce, communicate, critique, and renovate knowledge (Coffin, 1997; Fang, 2012; Monte-Sano, 2010; Yore, Hand & Florence, 2004) and the differences are reflected in how content experts use language in their practices (Fang, 2012: Fang & Schleppregrell, 2008; Schleppregrell, 2004). Discipline experts use language that is specific as they have standards on how to structure their texts, use vocabulary, and make appropriate grammatical choices to write texts.

Writing in the Content Areas

History

Current research has begun to examine content area literacy (Jetton & Lee, 2012) as we need to better understand the particularities that are in each specific discipline. By adolescence, students will be exposed to subject-specific texts and writing tasks that require specialized knowledge. For example, writings in history are constructed from evidence that has been questioned, pieced together, and interpreted (Monte-Sano, 2011). When we read historical texts we need to consider the perspective of the author of an account and the context in which that author was situated for a complete understanding. The environment and circumstances in which a historical event occurred are as important as the event itself. Thus, when we write on history we need to analyze the facts to express the accounts as written arguments rather than just list facts. The historian writer records the past events, argues a particular interpretation, and defends the stance with supporting evidence (Fang, 2012).

Research in adolescent reading has shown that historical texts contain long adverbial phrases and cohesive words to present historical events, people and institutions (Fang, 2012; Schleppegrell, 2004). This would suggest that students will also need to use these language structures to write their papers in their history classes. Students will use longer adverbial phrases to explain historical events in terms of place, manner and condition (e.g. *due to the fact that the organization that employed them had sent them overseas to monitor the stateside commercial interests*) and cohesive words to connect how one thing leads to another (e.g. *On the other hand, many Irish immigrants*).

Although students need to write in history classes, there are very few studies in the historical perspective (Monte-Sano, 2011). The ones that do exist focus on quality of writing. For example, Monte-Sano (2010) analyzed 56 written responses to a document-based essay question written by high school juniors in three U.S. history courses. The students were required to answer a question pertaining to the dropping of the atomic bomb in 1945 using specific documents. Monte-Sano analyzed the essays from the following five characteristics: Factual and interpretive accuracy, persuasiveness of evidence, sourcing of evidence, corroboration of evidence, and contextualization of evidence.

Science

Students will be required to write in the sciences. The purpose of science is to increase people's understanding of the natural world and its phenomena (Fang, 2012: Halliday & Martin, 1993; Schleppgrell, 2004). To do so, scientists systematically investigate meaningful questions about natural phenomena and evidence-based explanations. Scientists write in a range of sub-genres of expository text with the predominant one being a research report (Fang, 2010; Fang 2012). The research report "typically combines the five basic science genres of procedural account, procedure, report, explanation and exposition" (Fang, 2012, p. 24). The structure and nature of the research report allows scientists to explain, theorize, organize, and challenge science.

For students to be successful in writing scientific literacy they will need to have a solid grasp of technical vocabulary (Schleppgrell, 2004; Troia, 2006) and dense nominal syntax (Fang, 2012). For example, technical vocabulary is often far removed from a

student's everyday vocabulary and experience such as *eukaryotic cells, chloroplasts, ribosomes* and may be in acronyms such as DNA, RNA, or mRNA. The scientific vocabulary might also have terms that assume technical meanings such as cluster, solution, or splicing (Halliday & Martin, 1993; Troia, 2006). As students acquire competency in science, they develop greater depth of knowledge, related skills and strategies.

Another pervasive feature of scientific literacy is the use of nominal syntax (Banks, 2005). Nominal syntax occurs when authors use noun phrases that contain a large body of information that in everyday language would require many sentences to express (Halliday & Martin, 1993; Schleppgrell, 2004). Sometimes, these noun phrases can be also be long. For example, consider the following that contains long noun phrases: "competing RNA secondary structures that form between a single docking site and one of the selector sequences located upstream of each of the 48 alternative exonic sequences" (Fang, 2012, p. 24). In everyday language, this one phrase could be written as the following: "RNA secondary structures compete against each other. They form between a single docking site and one of the selector sequences. The selector sequences are located upstream of each of the 48 alternative exonic sequences" (Fang, 2012, p. 24). It is through many layers of syntactical modifications and embedding that individual pieces of information are incorporated and condensed into nominal syntax. Thus, nominal syntax allows scientists to develop chains of reasoning, draw conclusions from what they observe, and write a clear line of argument.

Nominal syntax in scientific literacy is presented through the nominalization process (Banks, 2005; Fang, Schleppegrell & Cox, 2006). Nominalization is a process by which verbs such as regulate, analyze and perform become nouns such as regulation, analysis and performance. This happens so that the verbs can become the arguments of other verbs or the objects of prepositions (Schleppgrell, 2004). For example, consider this sentence; "The invention of the telephone created many opportunities for enhanced communication" (p. 7, Schleppgrell, 2004). In this example, the verb *created* links the two nominal *the invention of the telephone* and *many opportunities for enhanced communication*. As a result, through the nominalization process, this sentence has the nouns *invention* and c*ommunication* rather than the verbs *invent* and *communicate*.

English Language Arts

The primary goal in English Language Arts (ELA) is to develop students' abilities to read, respond to, evaluate, and produce texts (Christie & Derewianka, 2008). Literature is the main focus in the discipline and it has many diverse text types and modalities (Fang, 2012). For example, literature includes many different genres such as poetry, drama, biographies, folktales, adventures, science fiction, and tragedies. Students are required to read, write, respond to and critique each of these different types of genres.

In ELA classes, students will write papers in which they relate events in a novel to their own lives and, like in the discipline of history, papers that compare different interpretations of texts (Kiuhara, Graham, Hawken, 2009). For example, students may be required to write an essay that compares and contrasts the text of *Dr. Zhivago* (Pasternak, 1986) to the 1965 film adaptation. The essay might be on character development which

requires students to present a view on the similarities and differences and support it with examples and evidence found within both interpretations of the story. Students reading or watching *Dr. Zhivago* may find the vocabulary and grammar easy to decode and comprehend as the story relates closely to concerns, emotions, imagination, dreams and other aspects of everyday life. As a result, the story line tends to have the similar language people use in their everyday lives (Fang, 2012). It is through simple language structures that the character's thoughts, actions, and dialogues are pulled together with description of actions that the author develops a scene to engage the reader.

Although the story dialogue and character development in *Dr. Zhivago* may be technically easy to comprehend, the students will use examples from the story and integrate it into an essay format that has more sophisticated language. Similar to the discipline of scientific writing, students will include in their essays elaborate noun phrases (e.g. *Pasternak's development of Nikolai Nikolaieveich's character*), technical and abstract vocabulary (e.g. Nikolaieveich's *intelligence*), effective use of logical connectors (e.g. *Moreover*, Pasternak's ability to) and relational processes that link nominal structures (e.g. *This change in character development* allows the author to exploit the political climate of his time) (Schleppegrell, 2004). ELA will also include the use of modal adjuncts to represent differing viewpoints (e.g. *In my opinion*, the written version is better).

This type of writing can be challenging for students as the syntactic complexity is greater in argument than in narrative or descriptive writing (Crowhurst, 1980). In the example of writing a compare and contrast essay on *Dr. Zhivago*, students must

effectively write using examples of the simpler language from the original story and embed it into a complex essay. They must show how their sentences and paragraphs are related as they elaborate and link the topic through lexical and grammatical organizations. Students need to understand the functions of different grammatical choices and vocabulary both in the simple language of Dr. Zhivago and the complex language of a compare and contrast essay.

Development of Writing

Analyzing writing development as a function of grade level is common in elementary and middle school students (Beringer, Cartwright, Yates, Swanson, & Abbott, 1994; Flower & Hayes, 1981) and in high school and college students (Crossley, Weston, McLain-Sullivan, McNamara, 2011; Oliver, 1995). Much of research has focused on the writing development of elementary and middle school students because the "developmental patterns are strongest at a young age and the opportunity to develop successful interventions are most likely" (p. 283, Crossley et al, 2011). The research examining the writing development of adolescents and adults is less common (Crossley, Weston, McLain-Sullivan & MacNamara, 2011; Kiuhara, Graham, & Hawken, 2009). However, it is important to understand the growth in the more complicated writing that develops at later stages and how these relate to increasing writing quality. With this understanding of typical writing development, professionals can provide the scaffolds needed to assist adolescent writers in expressing themselves more effectively (Nippold, Ward-Lonergan & Fanning, 2005).

Currently, there have been no known studies that have examined high school students' developing ability to use different language structures and forms in written texts for different disciplines. Most studies that have examined developmental writing in the adolescent period have focused on specific genres such as persuasive writing (e.g. Crossley et al, 2011; Nippold et al., 2005). Crossley et al (2011) examined the linguistic differences in writing samples of adolescents and young adult students in different grades. They collected essays from 9th and 11th grade writers and college freshman writers. The students wrote argumentative essays in response to prompts from the Scholastic Achievement Test (SAT) writing section. The essays were part of the course requirements in their class. The students wrote for 25 minutes. The linguistic elements of the essays assessed were cohesion (e.g. causality, incidence of connectives, incidence of logical operators, lexical overlap, semantic coreferentiality, and anaphoric reference), lexical sophistication (e.g. hypernymy, word polysemy, lexical diversity, word frequency, and word information indices), syntactic complexity (e.g. syntactic similarity and phrase structure complexity), and text structure (e.g. word length, number of paragraphs, and number of sentences).

Crossley et al (2011) found group differences at the word level, syntactic level, and with measures of cohesion at all grade levels. Cohesion predicted grade level but through the lack of cohesive devices. College writers used fewer cohesive words than the 9th and 11th grades and relied more on syntactic complexity to develop cohesive essays such as elements of a subsentence (i.e. modification and embedding). The strongest predictor of grade level writing was the number of words in a text with college level

writers having the longest essays followed by the 11th graders and finally the 9th graders. The strongest lexical predictor was word frequency and other indices of lexical diversity, word concreteness, and polysemy were also predictors of grade. Finally, syntactically, the college freshman essays contained more syntactically complex structures in the form of noun phrases. The noun phrases had more words. Overall, this study supports the notion that writing continues to develop through college.

Persuasive writing was investigated by Nippold, Ward-Logergan and Fanning (2005). Students with the mean ages of 11, 17 and 24 years wrote an essay on the topic of animals being trained in the circus. The essays were examined in detail on aspects of syntactic, semantic and pragmatic development. Each language domain showed an improvement with age. There was a gradual increase in essay length, mean length of utterance, and the use of literate words including adverbial conjuncts (e.g. typically, finally), abstract nouns (e.g. respect, kindness) and metalinguistic and metacognitive verbs (e.g. argue, disagree). Older writers were also more likely to provide a greater number of reasons in their essays and acknowledge diverse points of view. Use of nominal and adverbial clauses did not change in relation to age. This is similar to other findings that suggest subordinate clause production appears to reach a plateau by 8th grade (ages 13-14) (Crowhurst, 1980; Rubin, 1982; Rubin & Piche, 1979). Adolescents were more likely to use late emerging adverbial conjuncts (e.g. *consequently, on the other hand*) than younger children. Consistent with the findings in Crossley et al. (2011) adults did not use more adverbial conjuncts than the younger groups. The total number of words and utterances produced in the essays increased with age.

Narrative writing was examined by Sun and Nippold (2011). Students from grades 5, 8 and 11 participated in the study (n = 40 per grade). The mean ages were 11 years, 14 years, and 17 years. Students were required to write a narrative at school entitled "What Happened One Day." The essays were examined for the use of abstract nouns, metacognitive verbs, and number of T-units, and measures of clause density and mean length of T-unit (MLTU). Results indicated that 17-years olds outperformed the 11-year-olds on abstract nouns and metacognitive verbs and that the 14 year-olds outperformed the 11-years olds on metacognitive verbs. The 17-years-olds outperformed the 14 and 11-years-olds. On total number of T-units, the 17-years-olds outperformed the 11-years-old and the 14-years-olds outperformed the 11 years-olds on the clause density and MLTU.

Crowhurst (1987) found that the specific types of connectors that students used in persuasive essays changed as a function of grade level. She found that 6th graders were more likely to use earlier developing connectors such as *so, also, and, then* whereas 12th graders used later developing connectors such as *first of all, for this reason, next, on the other hand,* and *in conclusion*. She also noted that the 12th graders also used the earlier developing connectors less frequently. These findings indicate that the use of adverbial conjuncts and other connectors provides a measure of improving writing abilities through the later school years. In the same study, Crowhurst (1987) compared the use of cohesive ties in narratives to persuasive essays. She stated the "frequency of cohesive ties per 100 words was significantly greater for narration than for argument" (p. 198). She explained the differences due to the nature of narratives and persuasive writings. She stated that in

both types of writing genres, items are introduced into the essay and then repeatedly referred to. However, in persuasive writing there are more generalized statements reducing the proportionate need to use cohesive ties.

In addition to cohesive elements, writing development is also characterized by the use of more complex words. For example, Freedman and Pringle (1980) collected essays written in four disciplines: English literature, history, geography, and biology. The essays were written at home as part of an existing class assignment not a predetermined topic as part of a research design. Teachers from the classes were asked to give a sample that represented the range of students in class as defined by grading (e.g. A's, B's, C's, D's, and F's). The results indicated that vocabulary distinguished graduating high school students and 3rd-year college student essays whereas there were no differences noted in textual unity, organization, development, or coherence.

Purpose of the Current Research

The move towards discipline specific approaches to literacy learning suggests there is a growing realization that literacy practices vary across disciplines. To be successful in high school, students need to write in the language of specific disciplines such as history, science and ELA. Prior research has focused on the linguistic differences that occur in the texts that students must read. For example, science texts have technical vocabulary (e.g. *enzymes, cyclin*) and history texts have long nominal clauses (e.g. *the white leaders in Southern states like Alabama that enforced the laws).* Yet to be investigated is whether students are able to shift writing styles for different disciplines and whether third year high school students (11th grade) demonstrate noticeable

improvements in lexical and grammatical aspects of writing than first year high school students (9th grade). The purpose of the present study is to address this gap in the literature. The specific research questions and hypothesis addressed are:

Is there a significant developmental difference between the three discipline areas of history, science, and English Language Arts and the written syntax and semantics of students in 9th and 11th grade?

Is there a significant difference between the students in the 9th and 11th grade in the written syntax and semantics in the three disciplines of history, science, and English Language Arts?

It is hypothesized that adolescent writings in history will use more adverbial clauses, longer adverbial clauses, and more cohesive words than writings in ELA and science (Coffin, 2006; Fang, 2012; Monte-Sano, 2010: Monte-Sano, 2011; Schleppegrell, 2004). It is through adverbial clauses that history can be explained in terms of place, manner and condition; and through cohesive words that allow historians to connect how one thing leads to another.

Based on previous literature (Banks, 2005; Fang, 2012: Schleppegrell, 2004: Troia, 2006) scientific writing will most likely have more lexical complexity and longer noun phrases than adolescent writings in ELA and history. It is through specialized vocabulary that precision of information is presented, through a nominalization process of words and dense vocabulary that the complexity of the vocabulary increases to assist with condensation of information and through grammatical modification of noun phrases that allow scientists to increase the understanding of the natural world.

It is hypothesized that writings in ELA will most likely have longer sentences, more nominal clauses, and more abstract nouns than adolescents writings in the disciplines of history and science (Fang, 2012; Schleppegrell, 2004). Writers in ELA use clauses that are linked together through coordination, subordination, or both that create longer sentences and use abstract nouns to describe characters feelings, actions, dialogues, and thoughts.

Based on previous literature (Nippold, Ward-Logergan and Fanning, 2005; Sun & Nippold, 2010), it is hypothesized that there will be an increase in length of noun phrases, adverbial clauses and sentences, clause density, number of abstract nouns and relative clause production, and lexically complex words from 9thto the 11th grade in all three disciplinary writings. In the use of cohesive words, it is hypothesized that the number of words used will decrease between the 9th and 11th grade (Crossley et al., 2011). In the number of infinitive, nominal, adverbial, and conjoined clauses used, it is hypothesized that the number or each will remain relatively stable (Crowhurst, 1980; Rubin, 1982; Rubin & Piche, 1979).

CHAPTER III

METHODS

Participants

Participants were 22 typically developing 9th grade students (10 females and 12 males) and 22 typically developing 11th grade students (9 female and 13 male). Participants (*M* = 14 years 8 months and *M* = 16 years 10 months) were recruited from the same local high school in North Carolina. Recruitment letters and consent were given to students who met the inclusionary criteria. All participants spoke English as their primary language, and based on parent report, none were on individualized education programs or receiving special education services or received speech-language pathology services in the past. All participants were enrolled in Honor-level courses. Thus, all participants were considered to be free of any cognitive, socio-emotional, language, or learning disorders.

Recruitment letters and consents were also given to teachers of ELA, history, and science in both 9th and 11th grade. There were 6 teachers involved in this study with three in the 9th grade and three in the 11th grade.

The study was approved by the University of North Carolina at Greensboro Office of Research Integrity and by the county school Research Review Committee.

Procedures

Participants completed a short questionnaire regarding their age, gender, grade, and English Language skills. To assess comprehension of the content, participants were required to complete a short quiz, as part of the course requirements. The quizzes were created by the teachers as part of the assignment and graded accordingly. All writing samples were obtained in the students' school. Each writing sample was acquired through an in-class assignment that all students in the class were required to complete. All students in the class were required to write one expository text per discipline: social studies, science, and English Language Arts. All students had approximately 30 minutes to complete each written assignment. The primary researcher and the teacher were in the classroom when the participants took the quiz and wrote their responses to the prompt. The text was written in response to a teacher created prompt that was based on the class unit the students just completed (See Appendix 1). Only those students participating in the study submitted their written responses to the researcher.

Written language samples were transcribed and checked for accuracy. Utterances were coded and assigned a unique code (i.e. [ac] for adverbial clauses, [nom] for nominal clause). In the following example, the codes [ac] and [nom] will be assigned: *Although there was no evidence for growth of pathogens, considerable change in the microbiological community composition occurred which surprised the researchers.* Following the coding of the utterances, a frequency of occurrence count occurred for all 14 language measures (See Table 1). The 14 language measures were divided into 3 groupings based on common language features and each are described in the following.

Table 1. Language Measures

Measures of Productivity	Total Number of Words
	Total Number of T-Units
	Mean Length of T-Unit
	Mean Length of Noun Phrase
	Mean Length of Adverbial Clause
	Clause Density
Measures of Lexical Elements	Lexical Complexity
	Cohesive Words & Phrases
	Abstract Nouns
Measure of Clauses	Adverbial Clauses
	Nominal Clauses
	Infinitive Clauses
	Conjoined Clauses
	Relative Clauses

Measures of Productivity

Total Number of Words

All words were counted in each text. Proper names such as *Chief Running Bear* were counted as one word. Compound words such as *grandfather* were also counted as one word. Contractions such as ca*n't, won't* were counted as two words.

Total Number of T-Units

Total number of T-units produced for each writing sample was calculated. A T-unit is defined as an independent clause with any associated subordinate clauses (Hunt, 1965). An independent clause contains a subject and a main verb and can stand alone to express a complete thought (e.g. *Running can be fun*.) A fragment lacks a subject and/or a main verb (e.g. *Being forced to run*).

Mean Number of Word per/ T-Unit.

Number of words per T-unit was determined for each writing sample. Mean number was calculated by counting the total number of words used in a written essay and then divided by the number of T-units the essay contains.

Mean Noun Phrase Length

The length of noun phrases was completed for each written language sample. All noun phrases were coded and each word in the noun phrase was counted. The following is an example of a noun phrase: *the economic feasibility of ocean thermal energy for electricity generation.*

Mean Adverbial Clause Length

The length of adverbial clauses was completed for each written language sample. All adverbial clauses were coded and each word in the clause was counted. The following is an example of an adverbial clause: They examined the DNA structure *because the professor asked them to*.

Clause Density

Clause density was measured for each t-unit. All main and subordinate clauses in each written sample were counted and divided by the total number of T-units in the writing sample

Measures of Lexical Elements

Lexical Complexity

Lexical complexity was measured by counting the number of 3 or more syllable words written in a text (Berman & Nir-sagiv, 2007). The total number of 3 or more syllable words was divided by the total number of words used to determine lexical complexity.

Cohesive Words and Phrases

The total number of cohesive words and phrases used in a text was counted. They are words or phrases that introduce an independent clause and link it to a previous clause (Nippold, Ward-Lonergan & Fanning, 2005). Examples of cohesive words and phrases include *first, last, furthermore, therefore, in contrast* and *conversely.*

Percentage of cohesive words per sample was determined by dividing the number of cohesive words by the total number of words written in the essay.

Abstract Nouns

Percentage of abstract nouns per sample was calculated by dividing the number of abstract nouns by the total number of words written in the essay. These nouns refer to abstract entities that are not readily seen, heard, or touched (Nippold, Ward-Lonergan &

Fanning, 2005). Examples of abstract nouns include *knowledge, bravery, truth, friendship, joy*, and *compassion*.

Measures of Clauses

Adverbial Clauses

Percentage of adverbial clauses was calculated for each written language sample. The total number of adverbial clauses was divided by the total number of t-units used to determine the average. The following are examples of sentences with adverbial clauses: *If we don't arrive in Atlanta by 8 pm, we will miss our flight. When I returned, I found my dog very ill.*

Nominal Clauses

Percentage of nominal clauses was calculated for each student's text. The total number of nominal clauses was divided by the total number of t-units used to determine the average. The following are examples of sentences with nominal clauses: *What he believes is not important. I don't believe she told him.*

Infinitive Clauses

Percentage of infinitive clauses was calculated for each student's text. The total number of infinitive clauses was divided by the total number of t-units used to determine the average. The following are examples of sentences with infinitive clauses: John wants *to walk* home after work today. I wanted *to go* to the shopping center after work.

Conjoined Clauses

Percentage of conjoined clauses was calculated for each student's text. The total number of conjoined clauses was divided by the total number of t-units used to determine

the average. The following are examples of sentences with conjoined clauses: *Jack washed the dishes* and *Hannah dried them*. *The two terriers chased the ball* and *the golden retriever watched them.*

Relative Clauses

Percentage of relative clauses was calculated for each student's text. The total number of relative clauses was divided by the total number of t-units used to determine the average. The following are examples of sentences with relative clauses: He told us about the woman *who lives next door*. John doesn't like the table *that stands in the middle of the kitchen*.

Reliability

Inter-rater and intra-rater reliabilities were calculated on 25% of the samples for each measure used and was reported as percent of agreement for all samples. Disagreements were resolved through discussion. Inter-rater reliability was 95.16% for measures of productivity and clause density, 98.07% for measures of lexical elements, and 93.66% for measures of clauses. Intra- rater reliability was 96.63% for measures of productivity and clause density, 97.89% for measures of lexical elements, and 96.40 % for measures of clauses. Inter-rater reliability for transcription of words was 99.97% and intra-rater reliability for transcription of words was 99.99%.

CHAPTER IV

RESULTS

Table 2 presents the descriptive data for the five productive data measures (total number of words and T-units and mean length of noun phrases, T-units and adverbial clauses and clause density). A series of 3 (content area) x 2 (grade) repeated measure ANOVAs with Bonferroni adjustments (adjusted alpha = .008) were used for multiple comparisons. Effect sizes were computed using the eta-squared coefficient (η^2), which is frequently used in language research that involves group design (e.g., Nippold, Ward-Lonergan, & Fanning, 2005; Nippold, Billow & Tomblin, 2008; Rice, Tomblin, Hoffman, Richman, & Marquis). According to Cohen's (1969) general guidelines, .01-.04 is a small effect size, .05-.13 is a medium effect size, and .14-.50 is a large effect size. The descriptive terms small, medium, and large, can indicate to a degree which group can account for the findings (Meline & Paradiso, 2003). Significant findings were found in four measures, total number of words, total number of T-units, mean length of noun phrase, and clause density. The main effect for content was significant for all four of these measures (See Table 3), but there was a significant interaction between content area and grade for three of the measures: total number of T-units, mean length of noun phrase, and clause density. The effect sizes were large for the three measures.

Table 2. Measures of Productivity.

	English Language Arts		Science		History	
	9th Grade	**11th grade**	**9th Grade**	**11th Grade**	**9th Grade**	**11th Grade**
Total Number of Words						
M	250.68	264.18	227.64	222.14	250.18	239.95
SD	30.39	30.68	31.48	22.40	30.27	23.35
Range	189-301	212-322	169-281	187-258	185-291	196-281
Total Number of T-Units						
M	24.23	25.86	22.86	20.36	25.23	23.73
SD	3.42	3.89	3.75	2.65	3.38	3.43
Range	19-32	19-33	18-30	17-26	19-33	19-32
Mean Length of T-Unit						
M	10.49	10.47	10.05	11.04	10.06	10.23
SD	1.64	1.37	1.35	1.34	1.69	1.23
Range	8.15-13.48	8.24-12.44	7.84-12.26	9.04-13.58	7.11-13.55	7.76-12.68
Mean Length of Noun Phrase						
M	3.22	2.82	3.22	4.57	3.52	3.29
SD	.31	.27	.33	.67	.44	.39
Range	2.8-3.83	2.32-3.41	2.50-3.90	3.46-5.51	2.78-4.46	2.92-4.29
Mean Length of Adverbial Clause						
M	6.25	5.92	6.01	5.99	6.52	5.99
SD	.93	1.32	.85	.91	1.12	.90
Range	4.63-7.86	3.45-7.27	5.00-8.17	4.50-7.50	4.50-9.00	4.40-7.43
Clause Density						
M	1.73	2.00	1.60	1.50	1.61	1.79
SD	.27	.26	.25	.14	.26	.22
Range	1.31-2.33	1.60-2.45	1.30-2.30	1.26-1.74	1.35-2.21	1.44-2.0

Table 3. Statistics for Measures of Productivity.

	Content	Grade	Content x Grade
Total number of words	*$F(2,42) = 29.63$, $p < .001$, $\eta^2 = .41$	$F(1, 42) = .01$, $p = .92$, $\eta^2 = .00$	$F(2, 42) = 4.33$, $p = .016$, $\eta^2 = .093$
Total number of T-units	*$F(2, 42) = 19.71$, $p < .001$, $\eta^2 = .32$	$F(1, 42) = 1.00$, $p = .32$, $\eta^2 = .02$	*$F(2, 42) = 6.78$, $p = .002$, $\eta^2 = .14$
MLT-U	$F(2, 42) = 1.72$, $p = .18$, $\eta^2 = .04$	$F(1, 42) = 1.22$, $p = .28$, $\eta^2 = .03$	$F(2, 42) = 2.67$, $p = .08$, $\eta^2 = .06$
Mean length of noun phrase	*$F(2, 42) = 64.73$, $p < .001$, $\eta^2 = .61$	*$F(1, 42) = 78.76$, $p < .001$, $\eta^2 = .65$	*$F(2, 42) = 10.64$, $p = .002$, $\eta^2 = .20$
Mean length of adverbial clause	$F(2, 42) = .95$, $p = .39$, $\eta^2 = .02$	$F(1, 42) = .2.41$, $p = .13$, $\eta^2 = .05$	$F(2, 42) = .91$, $p = .41$, $\eta^2 = .02$
Clause density	*$F(2,42) = 43.81$, $p < .001$, $\eta^2 = .51$	$F(1, 42) = 3.86$, $p = .06$, $\eta^2 = .08$	*$F(2, 42) = 17.03$, $p < .001$, $\eta^2 = .29$

* Statistically significant differences between groups

Figures 1-3 display the interactions. For total number of T units (Figure 1), the main effect for content was due to the significant difference between science and history for 9th graders (Tukey, $p < .001$) and ELA and science for 11th graders (Tukey, $p < .001$). For mean length of noun phrases (Figure 2) the main effect for content was due to the significant differences between science, ELA and history for 11th grade students (Tukey, $p < .001$). For clause density (Figure 3), the main effect for content was due to the significant difference between ELA and science in 11th grade (Tukey, $p < .001$).

The main effect for grade was not significant for the three measures. Independent t-test were used to compare 9th and 11th grade performance across the three content areas (Table 3).There was no clear pattern of performance across grade for the three measures. There were significantly more T-units in 11th grade writings than 9th grade for science and history ($p < .001$) (Table 4), but as can be seen in Figure 1, 11th grade students produced fewer T-units in their ELA writings than 9th grade students. Noun phrase length was significantly longer in 11th grade writings than 9th grade writings for science ($p < .001$), but 9th grade students had significantly longer NPs than 11th grade students in ELA and history ($p < .001$).

Table 4. Independent Samples t-test for Measures of Productivity Between Grades.

	English Language Arts	Science	History
T-Units			
	t(42) = -1.48, p = .15 Mean Difference = -1.64 SE = 1.11	*t(42) = 2.5, p = .004 Mean Difference = 2.5 SE = .98	t(42) = 1.46, p = .15 Mean Difference = 1.5 SE = 1.03
Noun Phrase Length			
	*t(42) = 4.55, p < .001 Mean Difference = .40 SE = .09	*t(33.75) = -9.68, p < .001 Mean Difference = -1.35 SE = .14	*t(42) = 1.98, p = .05 Mean Difference = .23 SE = .11
Clause Density			
	*t(42) = -3.42, p < .001 Mean Difference = -.27 SE = .08	t(42) = 1.66, p = .10 Mean Difference = .10 SE = .07	*t(42) = -2.52, p = .01 Mean Difference = -.18 SE = .10

* Statistically significant differences between grades

Figure 1. Content by Grade Interaction for Total Number of T-units.

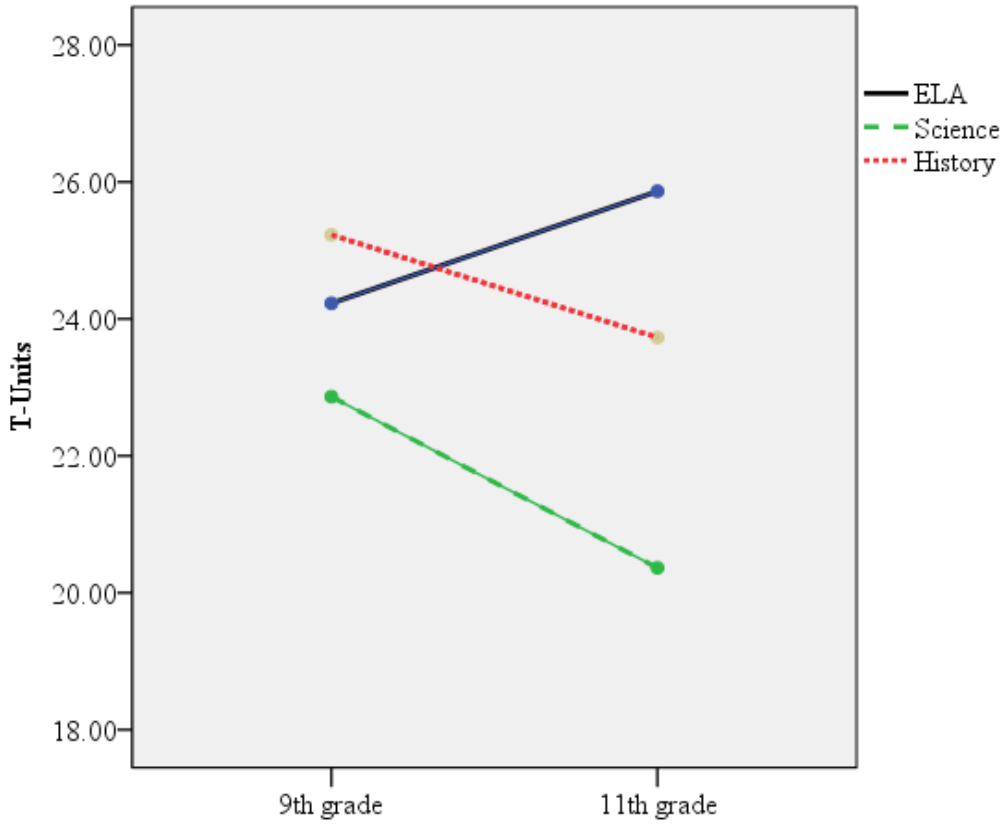


Figure 2. Content by Grade Interaction for Noun Phrase Length.

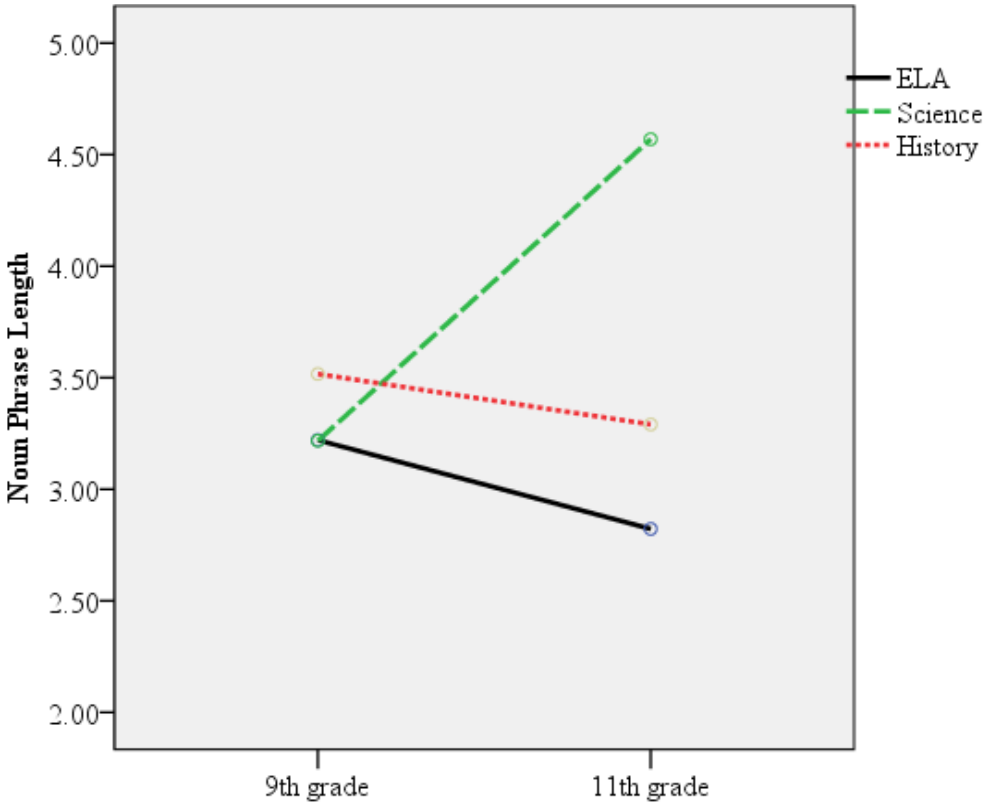
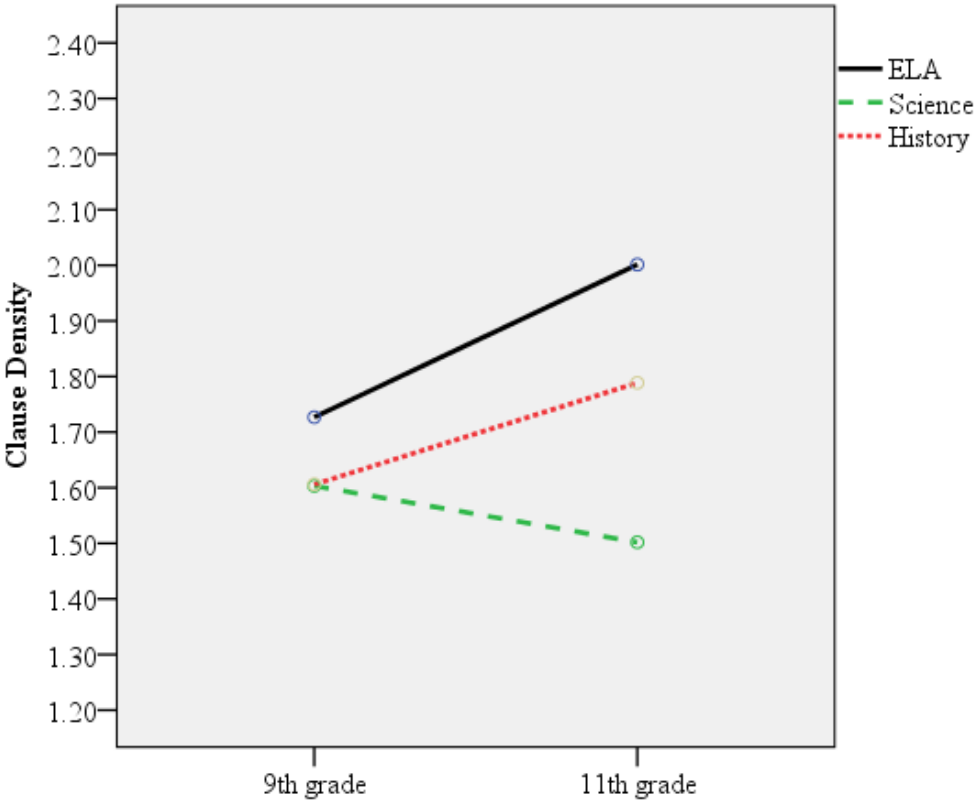


Figure 3. Content by Grade Interaction for Clause Density.



For total number of words, Tukey post hoc analyses indicated that 9th grade students produced significantly fewer words in science texts than history and ELA ($p <$ .001.) In 11th grade, students produced significantly more words for ELA texts than science and history ($p < .001$) and significantly more words for history texts than science ($p < .001$). The main effect for grade was not significant.

Table 5 presents the descriptive data for measures of lexical elements and are reported as percentage of total number of words (lexical complexity, cohesive words and phrases, and abstract nouns). A series of 3 (content area) x 2 (grade) repeated measure ANOVAs with Bonferroni adjustments (adjusted alpha = .0168) yielded significant findings (See table 6). The main effect for content was significant for all three measures but the interactions between content at grade were also significant. The effect sizes were large for the three measures.

Table 5. Measures of Lexical Elements Reported as Percentage of Total Number of Words.

	English Language Arts		Science		History	
	9th Grade	**11th Grade**	**9th Grade**	**11th Grade**	**9th Grade**	**11th Grade**
Lexical Complexity						
M	9.13	12.52	11.06	19.16	8.25	8.98
SD	1.57	1.22	1.32	2.89	1.84	1.12
Range	5.36-12.39	10.34-15.07	8.68-11.06	16.78-22.84	4.56-10.50	7.11-10.96
Cohesive Words/Phrases						
M	7.53	8.01	5.69	4.50	6.23	7.05
SD	1.31	1.33	1.72	.93	1.24	1.03
Range	5.30-11.47	5.42-11.11	3.45-10.16	2.89-6.31	4.24-9.45	5.49-9.44
Abstract Nouns						
M	1.44	.95	.23	0	1.42	1.38
SD	.47	.39	.29	0	.22	.13
Range	.73-2.39	.33-1.44	.00-.86	0	1.01-1.86	1.19-1.73

Table 6. Statistics for Measures of Lexical Elements.

	Content	Grade	Content x Grade
Lexical Complexity	*$F(2,42) = 227.19$, $p < .001$, $\eta^2 = .84$	*$F(1, 42) = 202.60$, $p < .001$, $\eta^2 = .83$	*$F(2, 42) = 73.70$, $p < .001$, $\eta^2 = .63$
Cohesive Words/Phrases	*$F(2, 42) = 53.61$, $p < .001$, $\eta^2 = .56$	$F(1, 42) = .02$, $p = .88$, $\eta^2 = .00$	*$F(2, 42) = 8.59$, $p < .001$, $\eta^2 = .17$
Abstract Nouns	*$F(2, 42) = 257.14$, $p < 001$, $\eta^2 = .86$	*$F(1, 42) = 7.00$, $p = .002$, $\eta^2 = .14$	*$F(2, 42) = 22.90$, $p < .001$, $\eta^2 = .35$

* Statistically significant differences between groups

Figures 4-6 display the interactions. For lexical complexity (Figure 4), the main effect for content was due to the significant difference between history and science in both the 9th and 11th grade (Tukey, $p < .001$). For cohesive words and phrases (Figure 5), the main effect for content was due to the significant differences between ELA and science for both 9th and 11th grade (Tukey, $p < .001$). For abstract nouns (Figure 6), the main effect for content was due to the significant difference between science and the other two content areas in the 9th grade (Tukey, $p < .001$) and between history and science in the 11th grade (Tukey, $p < .001$).

The main effect for grade was not significant for the three measures. Table 6 presents the t-tests for the grade comparisons across content area. As with the previous measures, there was no clear pattern of performance across grade for the three lexical measures. There were more significantly more lexically complex words in 11th grade writings than 9th grade for ELA and science ($p < .001$). Cohesive words and phrases were used significantly more in 11th grade writings than 9th grade writings in history ($p < .001$), but 9th grade students used significantly more cohesive words and phrases than 11th grade students in science ($p = .02$) (Figure 5). 9th grade students also produced significantly more abstract nouns than 11th grade students for ELA and science writings ($p < .001$).

Table 7. Independent Samples t-test for Measures of Lexical Elements Between Grades.

	English Language Arts	Science	History
Lexically complex Words			
	*t(42) = -8.04, $p < .001$ Mean Difference = -3.39 SE = .42	*t(37.83) = -16.52, $p < .001$ Mean Difference = - 8.10 SE = .49	t(42) = -1.58, $p = .12$ Mean Difference = -.72 SE = .46
Cohesive words and phrases			
	t(42) = - 1.21, $p = .24$ Mean Difference = -.48 SE = .40	*t(32.20) = 2.87, $p = .006$ Mean Difference = 1.19 SE = .42	*t(42) = -2.39, $p = .02$ Mean Difference = -.81 SE = .34
Abstract Nouns			
	*t(42) = 3.84, $p < .001$ Mean Difference = .50 SE = .13	*t(21) = 3.78, $p < .001$ Mean Difference = .23 SE = .06	t(42) = .79, $p = .43$ Mean Difference = .04 SE = .05

* Statistically significant differences between grades

Figure 4. Content by Grade Interaction for Lexically Complex Words.

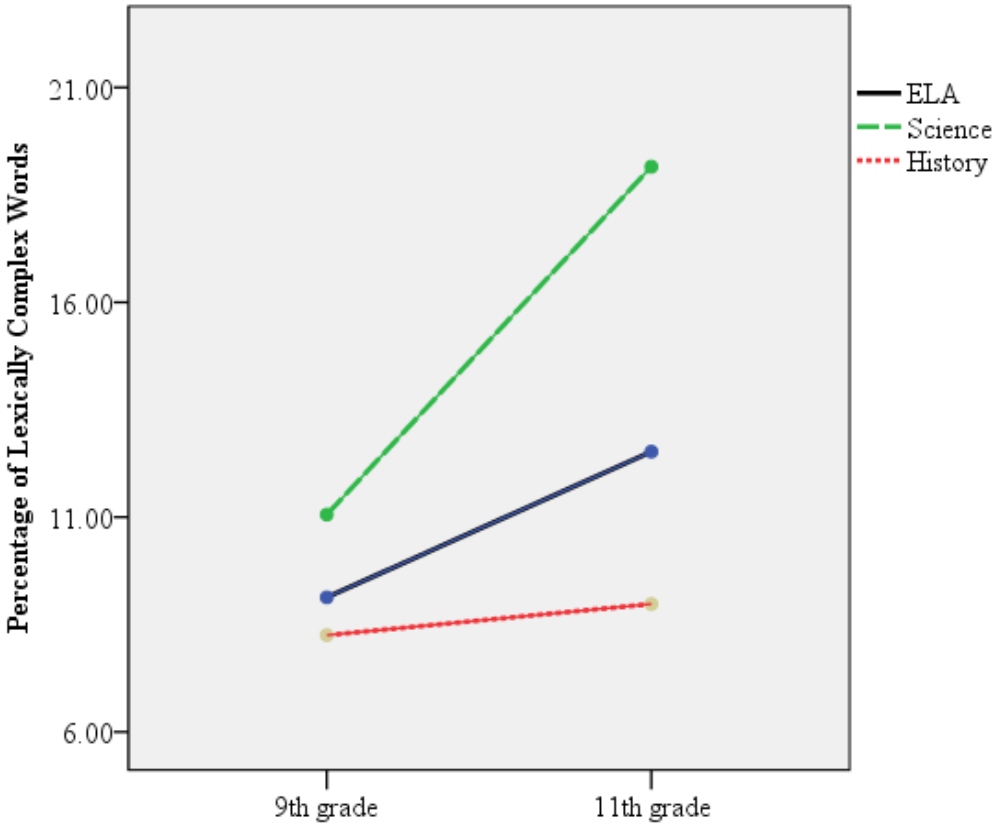


Figure 5. Content by Grade Interaction for Cohesive Words and Phrases.

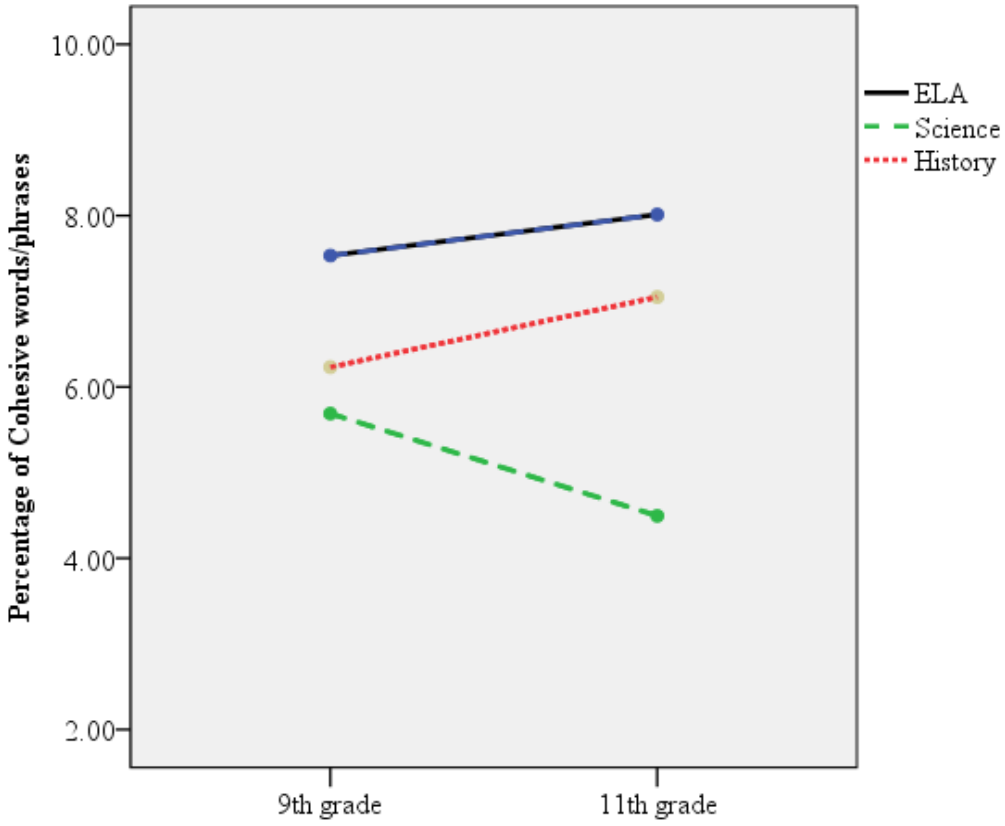


Figure 6. Content by Grade Interaction for Abstract Nouns.

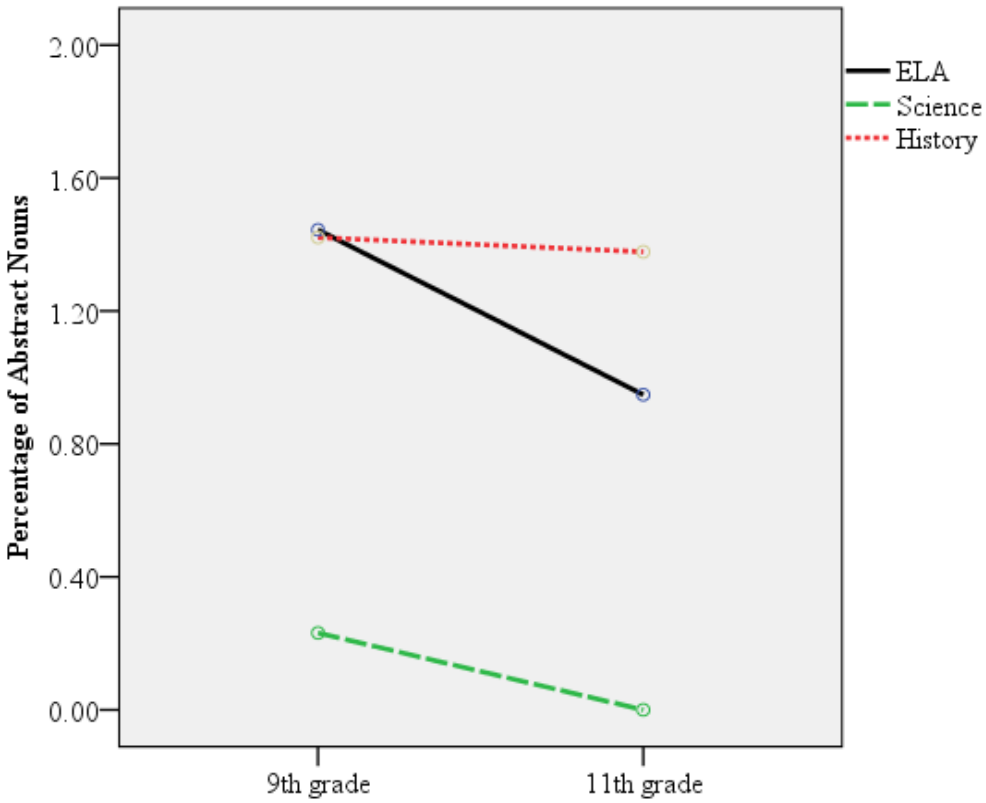


Table 8 presents the descriptive data for measures of clauses and are reported as percentage of total number of T-units (adverbial, nominal, infinitive, conjoined and relative clauses). A series of 3 (content area) x 2 (grade) repeated measure ANOVAs with Bonferroni adjustments (adjusted alpha = .01) yielded significant findings (Table 9). The main effect for content was significant for nominal, infinitive, and relative clauses (Table 8). As with the previous measures, the interaction between content and grade was significant for the three measures.

Figures 7-9 display the interactions. For nominal clauses (Figure 7), the main effect for content was due to the significant differences between ELA and history in 9th grade (Tukey, $p < .001$) and between ELA and science in 11th grade. For infinitive clauses (Figure 8), the main effect for content was due to the significant difference between science and the other content areas of ELA and history in 9th grade (Tukey, $p < .001$) and between history and science in 11th grade (Tukey, $p < .001$). For relative clauses (Figure 9), the main effect for content was due to the significant difference between ELA and science and history (Tukey, $p < .001$). For adverbial clauses (Figure 10), the main effect for content was due to the significant differences between ELA and history in both 9th and 11th grade.

The main effect for grade was not significant for the four measures. Table 10 presents independent sample t- test for measures of clauses between grades. There were significantly more nominal clauses in 11th grade writings than 9th grade in ELA ($p < .001$), but 11th grade students produced significantly fewer nominal clauses than 9th grade students in science ($p < .001$). 11th grade students produced significantly more infinitive

clauses in their ELA and science writings ($p < .001$). Relative clauses were used significantly more in 11th grade writings than 9th grade writings in ELA ($p < .001$). There were more adverbial clauses in 11th grade writings than 9th grade writings in history ($p < .001$), but 9th grade students used significantly more adverbial clauses than 11th grades students in ELA ($p = .003$).

Table 8. Measures of Clauses Reported as Percentage of Total T-units.

	English Language Arts		Science		History	
	9th Grade	**11th Grade**	**9th Grade**	**11th Grade**	**9th Grade**	**11th Grade**
Adverbial Clauses						
M	25.87	14.38	24.44	19.32	15.34	23.00
SD	8.94	6.42	9.73	7.11	8.93	6.92
Range	11.54-40	3.45-27.27	13.04-47.37	8.00-35.33	3.33-41.67	10.71-36.36
Nominal Clauses						
M	13.21	22.76	6.77	3.35	5.30	7.13
SD	6.23	9.33	3.08	2.89	3.88	4.80
Range	3.85-28.57	9.38-40.91	0-6.77	0-10.53	0-13.64	0-17.39
Infinitive Clauses						
M	13.48	26.88	13.42	14.38	20.75	29.26
SD	6.69	8.07	6.46	6.62	8.29	7.94
Range	3.85-31.58	16.00-45.25	4.17-26.32	4.17-26.32	8.33-42.11	14.81-43.48
Conjoined Clauses						
M	22.28	28.70	23.40	22.03	24.28	23.33
SD	10.44	10.59	7.46	14.82	9.03	12.71
Range	7.14-42.86	13.79-50.33	13.64-45.67	4.17-47.37	4.55-40.00	3.57-50.00
Relative Clauses						
M	15.61	34.52	12.82	8.53	13.66	12.57
SD	6.22	11.82	4.28	5.14	7.91	4.77
Range	7.69-28.57	13.79-59.09	4.35-20.00	0-16.67	3.85-36.84	3.57-20.00

Table 9. Statistics for Measures of Clauses.

	Content	Grade	Content x Grade
Adverbial Clauses	$F(2,42) = 1.86$, $p = .16$, $\eta^2 = .04$	$F(1, 42) = 2.72$ $p = .11$, $\eta^2 = .06$	*$F(2, 42) = 23.41$, $p < .001$, $\eta^2 = .36$
Nominal Clauses	*$F(2, 42) = 75.32$ $p < .001$, $\eta^2 = .64$	*$F(1, 42) = 7.44$, $p = .009$, $\eta^2 = .15$	*$F(2, 42) = 15.69$, $p < .001$, $\eta^2 = .27$
Infinitive Clauses	*$F(2, 42) = 37.36$, $p < .001$, $\eta^2 = 47$.	*$F(1, 42) = 21.17$, $p < .001$, $\eta^2 = .34$	*$F(2, 42) = 11.80$, $p < .001$, $\eta^2 = .22$
Conjoined Clauses	$F(2, 42) = 1.43$, $p = .25$, $\eta^2 = .03$	$F(1, 42) = .25$, $p = .62$, $\eta^2 = .01$	$F(2, 42) = 3.52$, $p = .03$, $\eta^2 = .08$
Relative Clauses	*$F(2, 42) = 59.86$, $p < .001$, $\eta^2 = .59$	*$F(1, 42) = 10.08$, $p = .003$, $\eta^2 = .19$	*$F(2, 42) = 39.89$, $p < .001$, $\eta^2 = .49$

* Statistically significant differences between groups

Figure 7. Content by Grade Interaction for Nominal Clauses.

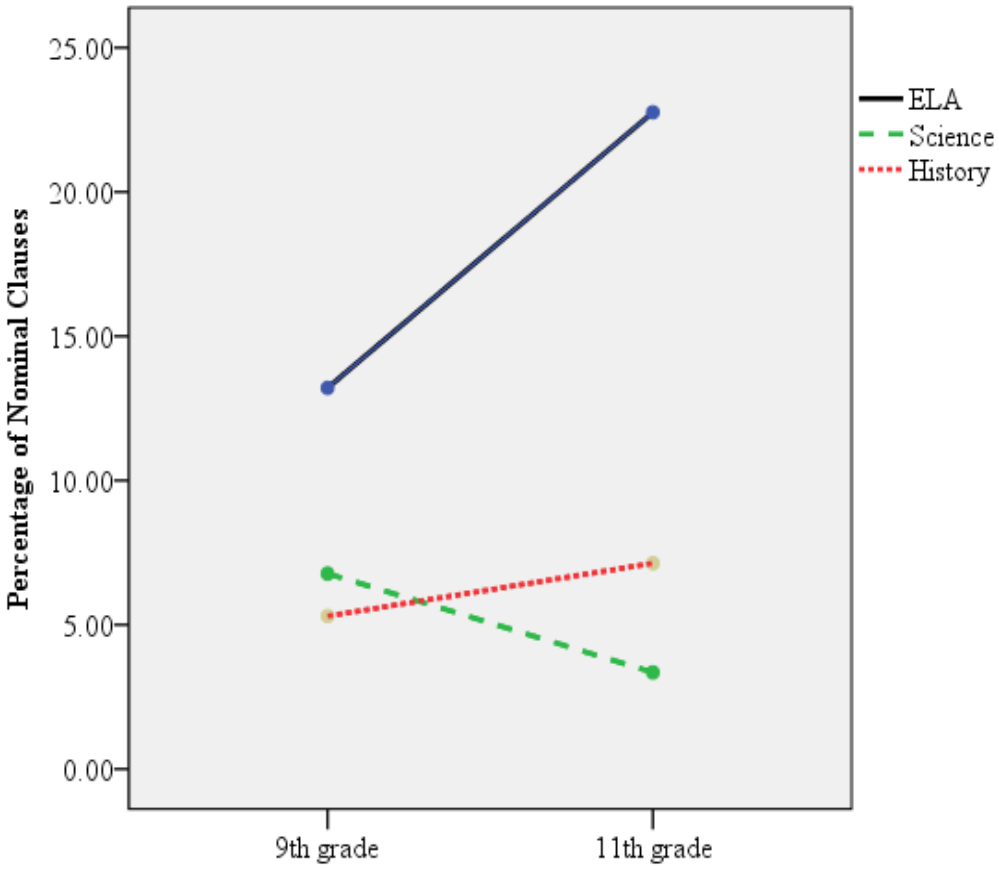


Figure 8. Content by Grade Interaction for Infinitive Clauses.

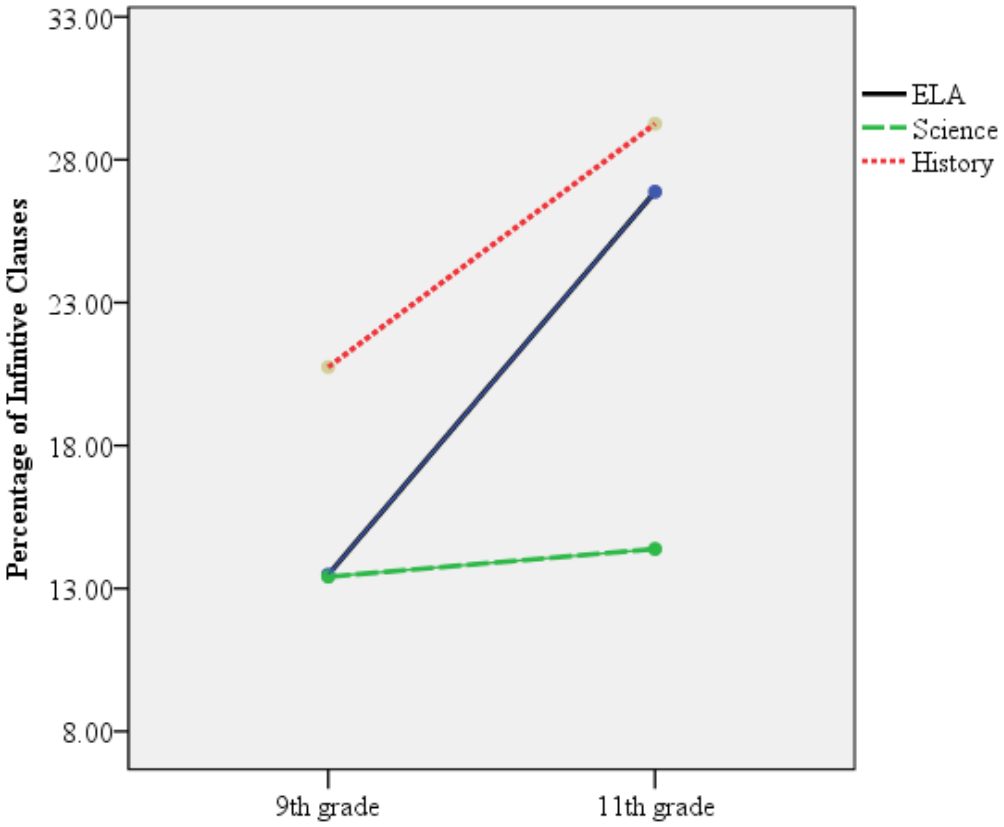


Figure 9. Content by Grade Interaction for Relative Clauses.

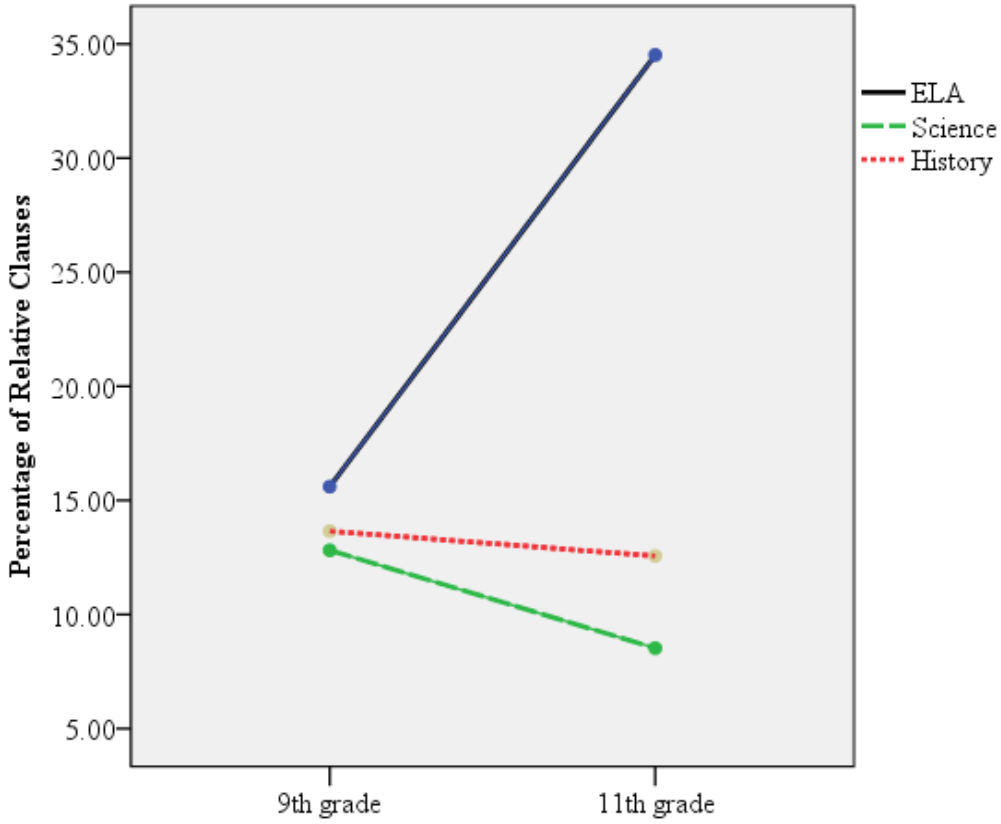
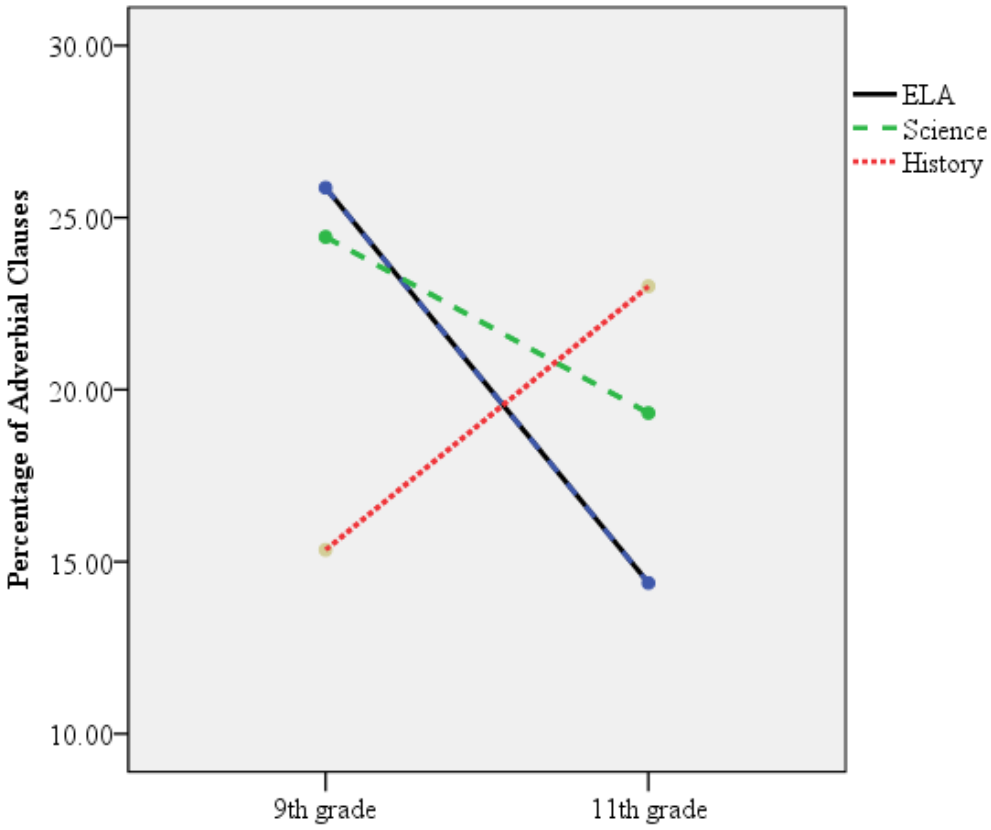


Table 10. Independent Sample t- test for Measures of Clauses Between Grades.

	English Language Arts	Science	History
Nominal clauses			
	*t(36.64) = -3.99, $p < .001$ Mean Difference = -9.55 SE = 2.39	*t(42) = 3.80, $p < .001$ Mean Difference = 3.42 SE = .90	t(42) = -1.39, $p = .17$ Mean Difference = -1.83 SE = 1.32
Infinitive clauses			
	*t(42) = - 5.99, $p < .001$ Mean Difference = -13.39 SE = 2.24	t(42) = -.50, $p = .62$ Mean Difference = -.97 SE = 1.97	*t(42) = -3.48, $p < .001$ Mean Difference = -8.51 SE = 2.45
Relative clauses			
	*t(42) = -6.65, $p < .001$ Mean Difference = -18.91 SE = 2.84	t(42) = 3.09, $p = .008$ Mean Difference = 4.29 SE = 1.43	t(42) = .55, $p = .58$ Mean Difference = 1.09 SE = 1.97
Adverbial clauses			
	*t(38.12) = 4.89, $p < .001$ Mean Difference = 11.49 SE = 2.35	t(42) = 1.91, $p = .05$ Mean Difference = 5.12 SE = 2.57	*t(42) = -3.18, $p = .003$ Mean Difference = -7.66 SE = 2.41

* Statistically significant differences between grades

Figure 10. Content by Grade Interaction for Adverbial Clauses.



CHAPTER V

DISCUSSION

The purpose of this study was to examine typically developing 9th and 11th grade students' ability to vary the linguistics elements when writing expository texts for the different disciplines of ELA, science, and history. Each participant produced three different essays, one in each discipline. The essays were written in response to prompts that were based on current class work. The major findings are discussed below.

Measures of Productivity

Measures of general productivity and syntactic units showed no clear pattern of performance. Based on previous research, it was expected that history writings would contain longer adverbial clauses than ELA and science writings (Coffin, 2006; Fang, 2012; Monte-Sano, 2010: Monte-Sano, 2011; Schleppegrell, 2004), that 11th grade writings would be longer and more clausally complex than 9th grades writing across the three disciplines, and that ELA writing would have a longer MLT-U. However, the length of adverbial clauses and MLT-U were similar across the three disciplines and a significant grade difference in the predicted direction was found only for clause density in ELA writings. It may be that these language characteristics, found in expert (prototype) disciplinary texts, do not exist in non-expert, adolescent student

writings and that students have not mastered the grammatical and lexical features. As noted by Crowhurst (1980), exposition is a difficult task and "is more cognitively demanding" (p. 229). Exposition uses linguistic forms that are not mastered early and these linguistic forms flourish from late adolescents on (Berman & Nir, 2010). Thus, it may be that adverbial clause length in history, increased clause density in history and science, and longer MLT-U in ELA develop further and increase in length beyond 11th grade and post-secondary education.

Schleppegrell (2004) noted that developing writers often "do not build their arguments from clause to clause, increasingly re-packaging and re-representing information as nominalized participants in the ensuing clauses" (p. 104-105). Instead, Schleppegrell suggests that the writers remain focused on the same information in a way that is typical of narrative writing rather than expository. This was evident as students in the history courses focused on naming or listing events from the past rather than answering the why questions and thereby not using complex grammatical features that are more commonly used in argumentative expository writing.

It was expected that ELA writing would have a higher clause density than history and science writings (Fang, 2012; Schleppegrell, 2004). This finding was supported as ELA sentences were more clausally complex than history and science sentences. See Appendix B to G for examples of student writings.

Surprisingly, 11th grade science writings were actually shorter and less complex than 9th grade science writings. This may be due to the type of sub-genre of expository writing that was elicited. The outcome of this research was designed to write in the

expository genre that is used in disciplinary literacy (i.e., a genre that is clearly distinct from the narrative genre). Similar to Berman & Nir (2010), the expository texts elicited in this research may represent a mixed type of sub-genres within the umbrella term of expository text. Specifically in this study, 9th grade students were asked to write an argumentative expository text and the 11th grade students were asked to write a laboratory report that included an argumentative expository text in the final section (Appendix 1). In this example, a *science report* has a specific purpose and is used to organize science information by dividing the scientific process into parts or steps and relate a set of facts using specific statements to back up general ones to explain why things happened (Scheleppegrell, 2004). A scientific *argument* argues why a thesis has been proposed, followed by a body of text that elaborates on the argument and ends with a conclusion that summarizes, and evaluates the points that have been made (Scheleppegrell, 2004). With these two types of sub-genres utilized, it may be that writing a science report required consistent use of longer noun phrases and that in turn influenced the number of clauses that were used (Ravid et al, 2010).

Measures of Lexical Elements

Measures of lexical elements also showed no clear pattern of performance. Previous research (Fang, 2012; Schleppegrell, 2004) suggested that that ELA writings would have more abstract nouns than history and science. ELA did have more abstract nouns but only compared to science and not history. The writings in history may have had more abstract nouns because, as suggested by Coffin (1997), history writers will use

abstraction through the nominalization process to present events in abstract terms such as the *industrial revolution* or people in generalized terms such as *settlers* or *Southerners*.

Based on previous research (Banks, 2005; Fang, 2012: Schleppegrell, 2004: Troia, 2006), it was expected that science writings would have more lexically complex words (i.e., three or more syllables in length) than ELA and history writings. Science writings had significantly more lexically complex words than ELA and history.

It was expected that the use of cohesive words and phrases would decrease between 9th and 11th (Crossley et al, 2011; Crowhurst, 1987) but this difference was not found. In the two studies cited, the difference between participants was more than the two grades that was utilized in this study. Crowhurst (1987) found significant differences between 6th and 12th grade and Crossley et al (2011) found significant differences between 9th grade and college students in the use of cohesive words and phrases. It may be that in this current study, a two-year age difference was not a large enough gap for changes to occur in the use of cohesive words and phrases.

Based on previous research (Nippold, Ward-Logergan and Fanning, 2005), it was expected that the use of lexically complex words would increase with age and this occurred in all three disciplines however, only ELA and science had significant increases. The topics for history writings may have influenced the types of words used and thus an increase was noted but it did not reach a significant level. For example, the 9th grade students were required to use words such as *convention, discrimination, amendment*, and *declaration* to describe the women's movement in the USA. The 11th grade students used

shorter words (e.g., *Cree, customs, teepee, wigwam, and small pox*) because of the topic they had to write about.

Measures of Clauses

Measures of clauses also showed no clear pattern of performance. It was expected that history would have more adverbial clauses than ELA and science (Coffin, 2006; Fang, 2012; Monte-Sano, 2010: Monte-Sano, 2011; Schleppegrell, 2004). The hypothesis was supported in 11th grade but not in 9th grade. This may suggest that developmentally 11th grade students are beginning to understand the need to use more adverbial clauses when writing about history.

Based on previous research (Fang, 2012; Schleppegrell, 2004), it was expected that ELA writings would have more nominal clauses than history and science. This hypothesis was supported for both 9th and 11th grades.

Based on previous developmental literature (Nippold, Ward-Logergan and Fanning, 2005), it was expected that the use of relative clauses would increase from 9th to 11th grade and this occurred in ELA, stayed approximately the same in history writings, and decreased in science. Although previous studies in persuasive writing and clause development found that relative clause production continues to gradually increase with age in persuasive writing (Nippold et. al., 2005), it may be that when looking at discipline specific writing, relative clause production is more aligned with writings in ELA than the other two disciplines. This would be similar to Ravid et al.'s, (2010) findings as they also looked at relative clause production and found that relative clause production was used significantly less in disciplinary specific discourse.

Based on previous developmental literature (Crowhurst, 1980; Rubin, 1982; Rubin & Piche, 1979; Nippold, Ward-Logergan and Fanning, 2005) it was expected that infinitive and conjoined clause production would remain relatively the same between grades and that occurred in the present study with the use of conjoined clauses in all three disciplines areas and infinitive clauses remained stable in science.

Limitations

There were several limitations in the present study. First, the students all came from the same high school. It will be important in future studies to expand the research to other high schools to increase the number of participants. Second, the types of prompts for the three content areas were different. For example, 9th grade science students wrote an essay about ocean energy where as in 11th grade, students wrote a lab report. It may be that some of the mixed results reflect mixed sub-genres as each sub-genre in science (Schleppegrell, 2004) and history (Coffin, 2004) might be more influenced by different language measures that were not included in this study. Third, the essays were not rated for writing quality. It may be that a relationship exists between different language measures and the quality of writings (Beers & Nagy, 2007).

Future Studies

The present study was limited in that the writing samples elicited were not in the same sub-genre of expository discourse between grades or disciplines. In future research, it will be important to examine the writing skills of adolescents using the same sub-genre between grades (e.g., science report) and between disciplines (e.g., explanation). It would also be beneficial to look at other age groups (e.g., 10th & 12th grade, post-

secondary education) to determine if these language measures have a developmental trajectory in disciplinary writing. In addition, it would be useful to look at other language measures such as the macro-structure or verb tense as well as to rate the quality of each essay written. Finally, studies that examine whether functional linguistic analyses, which have been shown to improve knowledge of disciplinary literacy, will also affect disciplinary writings would be beneficial.

Conclusion

Disciplinary writing requires the effective use of different lexical and syntactical structures. Although this study yielded mixed results, this study adds to the growing body of literature that high school students are beginning to acquire some knowledge about disciplinary literacy (Fang, 2012; Moje, 2007; Shanahan & Shanahan, 2012b). It was shown by the findings that 11th grade students used longer noun phrases and more lexically complex words in science writings and used more adverbial clauses in history writings. Also, students in both 9th and 11th grade used more nominal clauses and clausally complex sentences in ELA writings. As stated earlier, students need more than the basic writing skills to be successful writers in the disciplines. They need the skills to understand the ways that writing is produced and communicated in each discipline. These skills are beginning to emerge in high school.

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APPENDIX A

PROMPTS FOR WRITTEN ASSIGNMENT

Subject	Grade	Prompt
Science	9	On the following page, discuss in a one-page essay why ocean energy would be a valuable resource for our society. Your answer should include information on the different types of OTEC systems and examples on how we can protect and preserve the ocean.
	11	Laboratory Report For the past week, we have examined the effects of Sodium Chloride solutions on the germination rate of turnip seeds. In your own words, write a laboratory report of the results. You must include in your report an introduction with the hypothesis, a description of the dependent and independent variables, the procedures and the materials we utilized, and a conclusion.
English Language Arts	9	Characterization is an important aspect in writing and understanding a play. One minor character that is developed in The Crucible is that of Rebecca Nurse. The author, Arthur Miller, has Rebecca enter the play with the following description: "Rebecca Nurse, seventy-two, enters. She is white-haired, leaning upon her walking-stick." Write a minimum of a one-page essay on how her character develops from the moment she enters the play to the end explaining why her character is important to understanding the play.
	11	Write a minimum of a one-page review for the book "Cat's Cradle". Give your opinion on why you would or would not recommend others to read the book. Include a short summary of the book.
Social Studies	9	Write a minimum of a one-page essay describing the democratic struggles that women have faced in the United States of America between 1848 and the end of World War I. Begin with the first Women's Rights Convention in Seneca Falls, New York and end with World War I and the male veterans returning home. Considering the struggles that occurred during this period, do you think women have achieved equal rights today? Why or why not?
	11	In class, we have discussed the Plains and Woodlands Cree and that they have a long history in North America. Describe where they lived, their culture, lifestyles, and the different roles that were identified in their tribes during the 1700's and 1800's. Considering the long history in North America, do you think the Cree have equal rights today? The answer should be at least one page in length. Good Luck!

APPENDIX B

EXAMPLE OF 9TH GRADE STUDENT WRITING IN ELA

Noble, compassionate, gentle and wise are four words that describe Rebecca Nurse who is a character in the crucible. Rebecca Nurse is describing as a 72 years old white haired woman, and married to Francis Nurse. This physical description lets you know that she is a wise woman by her years in life and living experience. They had 11 children and 26 grandchildren.

Rebecca is a respected woman from a hard working family and gives her charity and kindness to Salem. She provides assurance, wellbeing, and wisdom to the community in which she resides. Rebecca is devoted to her husband. This is in character for her because she is a noble woman who devotes her time to her community and family. She is described as genuinely caring for her husband and her family.

Rebecca and Francis had many acres of land and rented it until he paid if off. Their children eventually lived nearby on the same parcel of land. This suggests that Rebecca and her husband are family oriented as the children chose to settle near them. She is respected and loved by her children.

Rebecca does not believe in witchcraft. She is a noble person who is a devoted believer of god's supernatural power. Although there are many people in her community that believe in witchcraft, she does not. She is a true believer in god. In fact, according to the reverend, who is a reverend from Boston and working in Beverly, that Rebecca has done good things. He has heard about her deeds through the community gossip.

APPENDIX C

EXAMPLE OF 11TH GRADE STUDENT WRITING IN ELA

Cat's Cradle is an interesting science fiction story that begins with John. John is writing a book about the day the atom bomb was dropped on Hiroshima. He sought to understand what people did on that day in history. In Cat's Cradle, John sends a letter to newt, who is the atom bomb's creator's son. Newt replies to the letter that he was 6 years old the day the bomb was dropped. He was in his home town of Ilium. John decides to travel to Ilium to meet the supervisor of the atom bomb creator. He meets the supervisor, Dr. Asa Breed. Following the meeting, John journeys to San Lorenzo to write an article about Julian castle. Castle is a multi-millionaire that used to own Castle Sugar Corporation. On the plane ride, John meets other interesting people, including Newt and Angela Hoenikker. They are 2 children of Felix Hoenikker. When John arrives, he learns that the leader of the island, "papa" Monazano, has terminal cancer. Monzano wants Fran (Felix's son) who is now a general of the island to be the new leader. John says no because he wants to marry the dictator's adopted daughter. At this point, the dictator takes the ice-nine which is a crystal seed that can freeze water and the body and commits suicide. Eventually the body ends up in the ocean, which turns to ice and kills many living organisms. John escapes with his wife but she also commits suicide. He meets Bokonan who is the co-creator of bokononism and co-founded San Lorenzo. But he also commits suicide. I found this book to be slow at first, however, eventually liked it. The

characters were complex and fun to follow. The plot had different twists, making it challenging to read. I would recommend it to friends who like sci-fi.

APPENDIX D

EXAMPLE OF 9TH GRADE STUDENT WRITING IN SCIENCE

It seems that ocean energy may have benefits for our society because. It is free energy. And that suggests that no fuel is needed or that waste is produced. The operations are clean and cheap to maintain. Ocean energy can can produce a great amount of energy. There are 2 types of ocean thermal energy conservation systems. The first is land based and the second is floating. The advantages of floating is that it can move offshore and generate electricity without the need for a shore. Landbased use some of the byproduct without expensive transport making it easier to use.

The ocean covers more than 70% of the earths surface and it is the world's largest solar collector. The sun heats the water on the surface and cannot heat the deeper water. The difference in temperature creates thermal energy that can be used for electricity generation. The OTEC produces power as the difference between the surface and deep water is 20 C. The best place for OTEC is between the tropic of Cancer and Capricorn. We can protect the ocean by buying recycled paper as 1 ton of recycled paper saves 7000 gallon of water. We can use fewer plastic products. We can conserve water by fixing leaky taps, and turning off water when we are not using it, buying water efficient appliances. We can also clean up beaches.

APPENDIX E

EXAMPLE OF 11TH GRADE STUDENT WRITING IN SCIENCE

This experiment is meant for the study of the effect of sodium chloride on turnip seed germination. The objective is to see if turnip sees will germinate in different solutions of sodium chloride. My hypothesis is that as the greater of concentration of sodium chloride increases, the germination rate will decrease.

The independent variables are the different concentrations of sodium chloride and the amount of water. The dependent variables are the turnip seeds and sodium chloride.

There are three different trials with five different concentrations of sodium chloride and a control group of salt concentration. The concentrations of sodium chloride are 1%, 2%, 3%, 4% and 5% to one millimeter of water. The time frame is 3 days. One millimeter of water is added on the first day, followed by no water on the second day, and half a millimeter of water on the last day.

The materials we utilized included petri dishes, turnip seeds, 5 concentrations (1%, 2%, 3%, 4%, and 5%), tap water, and sunlight.

The hypothesis was supported as the sodium chloride increased the germination rate decreased.

Most seed germinated in the control group (0%), some grew in the 1 and 2% solutions. But none grew in the higher concentrations of 3, 4 and 5% sodium chloride solution.

APPENDIX F

EXAMPLE OF 9TH GRADE STUDENT WRITING IN HISTORY

Women have been treated poorly compared to men. Women have fought for their rights for a long time. Begin in the colonial times men owned wives and children like property Women had to cook, sew, spin, clean and bear children. The first women's rights convention took place at Seneca Falls NY in 1848. It lasted 2 days with 68 women and 32 men signing the declaration of sentiments. It states the agenda for women's rights movements in the US

In 1850 the first national women's rights convention took place in Worcester Massachusetts with more than 1000 people. The first state to grant women the right to vote in 1893

Alice Paul and Lucy Burns formed the congressional union. It later was named the national womens party. They picked the white house to support the amendment that would support women's suffrage in 1917. 16 women were arrested and Lucy was identified as the leader and arrested in November. She was tied to the bars in jail.

On August 26, 1920 women are granted the right to vote. During ww1, women served and did not have to be disguise. In 1918 women served in the Marine Corps and men served over seas

After ww1 women could only serve as nurses. In ww2 more that 4 million women were fired from their jobs so the returning veterans could work.

Women have a long and hard history in the USA. Some women stood up to the laws to make change for women today.

APPENDIX G

EXAMPLE OF 11TH GRADE STUDENT WRITING IN HISTORY

The different types of Cree lived in the Northern parts of the USA and throughout Canada. In the past, when the Europeans came over, the Cree traded beavers for household items and such. However, they did not trade in 1838 because lots of their people died from small pox

Cree people had many customs and cultures. In the ceremonies they used drums and rattles and danced about living things on earth such as the chicken, sun and water. They buried their dead in shallow graves. They covered it in stone to protect the dead from animals

The Plains Cree and the Woodlands Cree lived differently. The plains Cree followed the buffalo for their survival and lived in teepees so that they could pick up and move wherever the buffalo roamed. Teepees are tent shaped and made out of buffalo hides. They are easy to break down and put up again. The Woodsland Cree did not live a nomadic lifestyle. The Woodsland Cree did not follow the buffalo. They hunted animals like beavers, moose, caribou, rabbits. They lived in wigwams. Wigwams are a birch bark building that do not break down

The roles of the people were based on their gender. Women took care of the kids, gathered berries and nuts, and skinned the hides of the animals and set up teepees. Men hunted for food and taught the boys how to hunt. The girls played games to help their moms.

No, the Cree have not equal rights today. They live on reserves and have high poverty and no employment.

APPENDIX H

MEASURES OF PRODUCTIVITY

Total Number of Words	All words were counted in each text. Proper names were counted as one word. Compound words were also counted as one word. Contractions were counted as two words.
Total Number of T-Units	Total number of T-units produced for each writing sample was calculated. A T-unit is defined as an independent clause with any associated subordinate clauses (Hunt, 1965). An independent clause contains a subject and a main verb and can stand alone to express a complete thought.
Mean Length of T-Unit	Number of words per T-unit was determined for each writing sample. Mean number was calculated by counting the total number of words used in a written essay and then divided by the number of T-units the essay contains.
Mean Length of Noun Phrase	Mean length of noun phrase was calculated by totaling up all the noun phrases and dividing by the number of words used in all the noun phrases.
Mean Length of Adverbial Clause	Mean length of adverbial clause was calculated by totaling up all the adverbial clauses and dividing by the number of words used in all the adverbial clauses.
Clause Density	Clause density was calculated by totaling up all main and subordinate clauses in the written text and dividing by the number of T-Units produced (Hunt, 1970).

APPENDIX I

MEASURES OF LEXICAL ELEMENTS

Lexical Complexity	The total number of 3 or more syllable words was divided by the total number of words used to determine lexical complexity.
Cohesive Words/Phrases	The total number of cohesive words and phrases used in a text was counted. They are words or phrases that introduce an independent clause and link it to a previous clause (Nippold, Ward-Lonergan & Fanning, 2005).
Abstract Nouns	Percentage of abstract nouns per sample was calculated by dividing the number of abstract nouns by the total number of words written in the essay. These nouns refer to abstract entities that are not readily seen, heard, or touched (Nippold, Ward-Lonergan & Fanning, 2005).

APPENDIX J

MEASURES OF CLAUSES

Adverbial Clauses	The total number of adverbial clauses was divided by the total number of t-units used to determine the average.
Nominal Clauses	The total number of nominal clauses was divided by the total number of t-units used to determine the average.
Infinitive Clauses	The total number of infinitive clauses was divided by the total number of t-units used to determine the average.
Conjoined Clauses	The total number of conjoined clauses was divided by the total number of t-units used to determine the average.
Relative Clauses	The total number of relative clauses was divided by the total number of t-units used to determine the average.