2010

Multi-modal Reading For Low Level Readers

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MULTI-MODAL READING FOR LOW LEVEL READERS

by

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in the Department of English, Texts and Technology
in the College of Arts and Humanities
at the University of Central Florida
Orlando, Florida

Summer Term
2010

Major Professor: Paul Dombrowski

ABSTRACT

The value of this research hinges on the idea that exchanging illustrations for descriptive text can provide appropriate schemas for students with reading difficulties and thereby improve their comprehension and vocabulary acquisition. The research in this dissertation is based on theories and earlier research in the fields of psychology, education, reading, and narratology. A review of these fields offers a variety of perspectives on the processes involved in reading and comprehension. These processes range from the physical systems involved in reading (e.g., early childhood development, eye movement) to the psychological systems, which include cognitive load theory as well as image and text processing models.

This study compares two reading methods by analyzing students' vocabulary and comprehension gains. Both groups read the same text and completed the same pre- and post-tests. The control group read the text from the book which was text only. The experimental group read from a modified text on the computer screen. The text was modified by replacing some sentences with images designed to transmit the same information (e.g., descriptions of the setting, vocabulary items) in a graphic format. The images were in-line with the text, and designed to be read as part of the story, not as additional illustrations.

Final analysis shows that the experimental format performed as well as the control format for most students. However, students who have learning disabilities, particularly language learners who have learning disabilities, did not make gains in the text only control format. These same students did show statistically significant gains with the experimental format, particularly the section of reading where the vocabulary words were explicitly presented in the images.

Disparate, non-homogenous groupings of students reflect the actual teaching and learning circumstances in the school, as required by the school system. This situation thus represents the actual status quo situation faced by teachers in our school. We leave it to future researchers to work with more homogenous groups of students in order to attain clearer, stronger and more plaintively useful results.

This work is dedicated to my mother, for teaching me the wonder of reading, and for always believing in me.

ACKNOWLEDGMENTS

I would like to acknowledge the hard work of my committee members and their diligence in making this work better than it would have been without their comments, consultations, and dedication. In particular, I am grateful to Dr. Dombrowski, for his consistent encouragement and guidance throughout.

For the tolerance and understanding of my family who have put up with the long hours, tension, and bouts of temporary insanity, I am grateful. I want to especially thank my daughter, Erin, who has sat and read while I attended classes or study groups, who put up with some rather interesting meal plans, and for whom I could not bear do anything less than my very best.

I greatly appreciate the support and dedication of the teachers with whom this study was conducted. They work with these students daily, and their guidance and participation made a world of difference in the quality of the design of this research. Also, the support of the administration and faculty at the study site was outstanding. And my heartfelt thanks goes out to the students who did their best to make this study a true test of the methods involved.

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CHAPTER 1 - INTRODUCTION

The premise of this dissertation has been percolating in the back of my mind since I was in my late teens. Growing up in a very small town in Oklahoma, there were only two escapes from boredom for me. Physically, sports allowed an outlet for the competitive energy, while reading allowed for a more esoteric escape into worlds of imagination and mystery. I had read over a thousand books by the time I reached junior high school, and, having run out of adolescent series available at our public library, I started on F. Scott Fitzgerald and Stephen King with equal enthusiasm. I could never understand why anyone would not enjoy reading—until I tried reading *The Hobbit*. The detailed descriptions in this book simply would not allow my imagination to engage; I could not get past the details to get to the action. I floundered. For the first time I could remember, I put a book down and walked away without finishing it. Was this what it was always like for my friends who hated reading?

Decades later, working as the Technology Coordinator in a middle school in Florida, I facilitate all sorts of specialized programs, including those designed to help students with difficulty in reading. I evaluate computer programs, order equipment for individual learning, and often help supervise a lab full of students, guiding them through both the passage on-screen and the demands of the software. I am amazed at the variety of ways software programs such as Journeys and Read 180 have been packaged so that, for all the pretty colors and the interactive links, the programs still boil down to text, and those students who cannot read text on paper

cannot read digital text either. In order to achieve different results for these students, something has to change.

The research conducted for this dissertation was a common-sense counterapproach to the mentality that, if students just read more, they will read better. This cannot be true if the reading itself is flawed. If I do not know how to solve a calculus problem, giving me more problems to solve will not improve my ability. Repeatedly reading words I do not understand will not make me understand them. As adults interacting with small children, we instinctively respond to a lack of understanding by using a variety of communication methods. When we do not understand what they are saying or they do not understand us, we show them. We give them the information in a visible or tangible format. We should back up to that stage with low-performing students and let them assimilate the visual with the symbolic so that the words they are reading connect to mental images such that meaning can be made. This basic idea gave rise to my research topic.

Much advancement has been made in the study of reading and cognitive psychology, and this research topic has come from a compilation of concepts, theories, and prior research findings on the topic of reading across multiple disciplines. There has been significant study of the combination of images and illustrations with text in the realm of reading research in the field of Education and Psychology. These findings build a solid foundation for the work in this dissertation. The physical process of reading, the study of the mental process of encoding and decoding symbol sets, and the study of literacy as it is applied to a variety of communication mediums are all reviewed and interwoven in the current work.

In an effort to apply the principles of Cognitive Load Theory and research on mental imagery, cognitive mapping, and schema building, I proposed that replacing some portions of text with comparable images should allow pre-adolescent and early adolescent students to

modify their existing schemas during reading, facilitating story comprehension and speeding vocabulary acquisition. In the course of the data analysis for this study, it was the disaggregation of data into subgroups which led to the realization that the method employed statistically affected students with learning disabilities in particular. Notably, the experimental format of the text did not adversely affect the scores of any of the students in any categories. However, for the group of students who had been assessed as having any type of documented learning disability, the experimental method out-performed the control of text-only. The reading consisted of a selection of the first two chapters of a selected work, and this performance disparity was only seen for the first of the two chapters. The experimental reading format replaces certain bits of text with images, and in the first chapter, those images are direct depictions of vocabulary words tested, as opposed to the images in the second chapter, which were oriented more toward the story setting and context.

The students with learning disabilities were further subdivided into those who were native English speakers, and those who were learning English as a second language. In this deeper analysis, the native speakers statistically did more poorly in the text only version of the first chapter of the reading, but did statistically equally well with both the text only and text with images version for the second chapter. However, for the students who are learning English as a second language, the only positive results were seen for the experimental reading format of text with images, and only for the first chapter where the images are explicit depictions of the vocabulary words being tested.

Chapter 1 of this dissertation offers an overview and commentary on the developments of psychology, language acquisition, the development of reading skills, the theories and impact of multimedia learning, and theories related to content learning. This is a broad overview, designed

to show the interconnectedness and common heritage of today's distinct fields of Psychology, Reading, and Narratology. Chapter 2 offers a more specific contextual discussion of particular theories that directly impact the focus of this study, how those studies were organized, and their results as they pertain to this research. The journey to this point has covered a broad spectrum of ideas and theories. In order to construct a firm foundation for my proposition, it is necessary to review quite a bit of the history of psychology, reading, and learning theory. Chapter 3 describes the materials and methods for this study, as well as establishing the need for this study. Much work has been done in various fields that relate to this research, but this specific study answers a fundamental question regarding reading and the impact of integrated images for those students who have the most difficulty with the reading process. Chapter 4 provides the results of this study, and analyzes these results in comparison to previous research and the implications thereof. Chapter 5 offers a reflection on the study, the implications for future research, and concluding remarks.

Historical and Pedagogical Background

First in this background is a history of psychology, presented as a rough chronology, with specific sections on working memory and attention, cognitive load and related theories, and developmental psychology, which leads into the section on language acquisition. The second section focuses on the study of language acquisition and pedagogy of reading. This second section includes the study of how we read, with emphasis on the process of decoding, comprehension, and meaning making. This discussion looks at theories and models of the reading processes, as well as commentary on theories of multimedia presentations and theories of content learning best practices. This organization offers a thorough background of each

discipline and, more importantly, shows the points where theories overlap and lead into the research portion of this dissertation. I will attempt to show clearly how theories and models of psychological processes, language acquisition, and reading skills have run parallel courses. Further, I intend to show how utilizing key discoveries from each of these fields gave rise to the research in this dissertation.

A Brief Overview of Psychology Relating to Reading, Teaching, and Learning

Wilhelm Wundt (1832-1920) began to focus his studies on physiology around 1855, eventually resulting in a theory of psychology based on the methodical observation of physiological responses in experimentally controlled situations. This ideology and justification that experimental research should not be restricted to the natural sciences but should be included as an important part of the mental and social sciences is considered the beginning of experimental psychology. According to George Mandler in *A History of Modern Experimental Psychology*, Wundt distinguished between experimental psychology and ethnopsychological or social psychological topics, which he felt could not be studied experimentally (56). For Wundt, experimental psychology was primarily sensory psychology, including "sensory processes, perception, consciousness, attention, will, affect, and time and space perception" (Mandler 56-57). Wundt's experimental psychology had a profound effect on the Western concept of psychology, very likely due to the migration of several of Wundt's students to America where they opened many of the laboratories dedicated to experimental psychology, generally equipped with imported German instruments (Mandler 59).

A key feature of Wundt's work, which moved psychology into the realm of the "hard sciences," was his insistence that the observer must be outside and independent of what is being

observed. However, Wundt's restrictions that experimental study was only viable when it was possible to manipulate the conditions and that all complex processes are composed of the compilation of simpler processes limited the kind of work that could be done with his methodology. This system could not be applied to higher order, complex mental processes due to high levels of individualization. For Wundt, it was only possible to study such systems through collective data of observations since the stimulus or conditions could not be controlled. Therefore, Wundt placed the study of such processes into the social psychology studies (Mandler 60-61). In particular, Wundt's stringent framework led to the rise of the field of behaviorism in America, such that other theories and concepts were marginalized for several decades. According to Mandler, "Wundt's brilliant breadth of vision was limited in its lack of attention to the psychological details of human consciousness, memory, emotion, and similar complex phenomena. That slack was taken up thousands of miles away by William James" (61).

William James's work, *The Principles of Psychology*, creates a strong foundation for this dissertation with his insistence that we form images and impressions in our minds based on the entirety of an object. In his chapter entitled "Imagination," James argues:

> …our ideas of single complex impressions are incomplete in one way, and those of numerous, more or less similar, complex impressions are incomplete in another way; that is to say, they are *generic*, not *specific*. And hence it follows that our ideas of the impressions in question are not, in the strict sense of the word, copies of those impressions; while, at the same time, they may exist in the mind independently of language. (47)

He moves forward with this argument and clarifies that this vague memory image is not the same as the abstract of the idea of what the image represents. It is a sketch or an echo of an impression (James 48).

James disagreed with the suggestion that imagination or images are stored in the same way for all people and instead felt each imagination needed to be studied, that each was built independently, with individual focus and varying points of emphasis (James 50). This idea of individualization in processing images and the method of storing information and memories brings to mind the later theories by Richard Mayer and Ruth Clark, as well as Wolfgang Schnotz and Maria Bannert (among others) of cognitive processing and will be discussed in relation to those theories later. James also argues that there are those with strong mental imagery skills and those without. Specifically, he notes that it seems that those without strong imagery skills will say they "know" or "remember" things and that in such cases recall seems to be a more linguistic memory than visual (James 57-58). He also remarks that it is often difficult for those with strong visual imagery skills to imagine how anyone could be without this skill—and that those without the skill often feel that the others are exaggerating or embellishing. This is similar to my personal experience of not understanding why anyone would hate reading—until I had a frustrating experience of my own.

James coined the phrase "stream of consciousness" and published a paper with that title in 1892. In this paper, he brings forward the idea of paying attention to paying attention—as well as discussing what is going on in our minds when we are not paying attention per se. His writings on the concepts of attention and memory distinguished between retention and recollection (Mandler 69). Specifically, in his 1892 paper, James notes that, although we actually ignore most things before us (in our selection of what is to be attended to or focused on), we

perceive collections of things as meaningful wholes ("Stream" 170-74). In this paper, he states that we mentally construct figures from collections of dots or lines; shadow and light are converted into images; and we group items either by proximity or similarity into meaningful collectives (James, "Stream" 168-170).

The concept of schemas, which will also be discussed later with regard to their role in reading comprehension, fits into this premise of interwoven knowledge. We have sets of concepts in our minds, such as the collective idea of a restaurant—you can call up the idea of the outside of a restaurant, the clinking of glassware, the smells from the kitchen, and any number of other associated bits of memory. Our mind does not file things with the structure of a clerk, placing everything in alphabetical order, but more in the style of a favorite aunt whose house is cluttered with everything under the sun, but it is grouped into piles that make perfect sense to her. William James, with his insightful approach to problem solving, recognized this over a hundred years ago. These mental collections based on personal associations form the structure of each person's schemas. The research for this dissertation hinges on the idea that exchanging descriptive text for prefabricated illustrations can provide appropriate schemas for students with reading difficulties and thereby significantly improve comprehension.

The End of Behaviorism

Behaviorism, based on the research frameworks established by Wundt, dominated in psychological study in America from the 1910s until the mid-1950s, when computer technology began to affect the way we viewed the mind. Studies shifted from strict genetically determined cause and effect to a construct based on the idea of programming and pattern formation. Of particular note is the 1956 paper by George Miller, which showed the capacity of short-term

memory to be seven items (plus or minus two). An additional impetus in the shift of interest in psychological study occurred in the late 1950s with the discord between B.F. Skinner and Noam Chomsky on language acquisition and development. Skinner's publication of *Verbal Behavior* in 1957 attempted to take behaviorism laws of simple tasks and apply them to the more complex task of language processing. In 1959, Chomsky's review of Skinner's work attacked both the book and behaviorism as a whole, arguing that simplistic behaviorist principles were insufficient for the study of language. Chomsky's own publication from 1957, *Syntactic Structures*, formed the foundation for a new era in language studies based on the idea that we constantly construct novel sentences by combining words in ways that follow learned patterns of grammatical rules, rather than using intact learned phrases (Rayner and Pollatsek 7). Language is generated, not memorized. This interest in the developmental aspects of language set the stage for the introduction of Jean Piaget's work in early childhood development.

In 1961, Piaget's works, which had been published in France in the 1920's and 1930's, were translated into English and came onto the scene in America. Piaget's study of children and his documentation of their stages of development suddenly ignited a renewed interest in early childhood studies which led to a resurgence of interest in the pedagogy of reading. Edmund Huey's 1908 book, *The Psychology and Pedagogy of Reading*, was republished in 1968 (Rayner and Pollatsek 6) and was still the authority on the study of reading due to the dearth of interest in the subject in the interim. Interest was renewed in the internal workings of the mind, in the modes of processing verbal and textual input, and the intricacies of the mind's ability to make meaning. The study of psychology shifted from a focus on stimulus and action and moved into a new era.

Working Memory, Attention, and Cognitive Load

The subjects of working memory, attention, and cognitive load form the foundations of the study of the limits of the mind's capacity and interrelated working. Ultimately, in this dissertation, I want to combine the research findings in these fields with those in visual comprehension (including text, images, spatial cues, and the combination thereof), language acquisition, comprehension, and verbal cuing in order to create a broader understanding of the interactivity and relationships between these areas that lead to the formation of this research topic. This section provides a history of the development of working memory, attention, and cognitive load and the progression of the theories and models of these systems.

Endel Tulving, in *Varieties of Consciousness and Levels of Awareness*, listed five classifications of memory systems which were developed in 1991 (285). Listed in order of their development, from lowest (can function independently) to highest (is dependent on all lower systems but has special properties of its own), they are: 1) procedural memory, which equates to skill learning, 2) perceptual representation, which allows the cognitive system to be "primed" with a suggestion or word that is perceived but not necessarily attended to, 3) short-term memory, generally known as working memory or primary memory, 4) semantic memory, which forms the knowledge system and generic memory of everyday items, such as the meaning of the word "generic," and 5) episodic memory, which contains autobiographical information and personal memories. Semantic (implicit retrieval) and episodic (explicit retrieval) together form long-term memory (Tulving 285-86). Procedural memory is an "action" system (e.g., learn by doing, muscle memory), while the other four are "cognitive" systems.

Cognitive load is the term used to describe the amount of strain placed on the cognitive system of perception, meaning making, processing, and storing or retrieving memory. Although

memory span is affected by the number of items in a list, the word length also has an effect, reinforcing the idea of phonetic encoding. The memory phenomenon associated with the magic number seven presented by Miller has gone through interesting alterations. In a study done using the digit span test in the Welch language, where names of numbers are phonetically longer, fewer digits could be held in memory, suggesting that the capacity is limited by the number of syllables, rather than digits (Just and Carpenter 125; Baddeley 191). This could be explained by trace decay, where the time it takes to work through the list means that items at the beginning of the list have time to be forgotten before rehearsal can set in to maintain them in memory.

Researchers have studied various combinations of mental demand on the cognitive system. In *Working Memory or Working Attention?*, Alan Baddeley notes several studies, his own and others over the course of nearly thirty years (from mid 1960's to 1989) , that led to the now-accepted idea that articulation of information is a key coding strategy. This is comparable to repeating a telephone number aloud or silently until one can find paper and pen to write it down. In particular, the greater the amount of articulation, the better the performance on memory span tasks, while articulatory suppression (uttering a nonsense syllable or word such as "the" or "la" during a memory task) significantly lowered performance (Baddeley 191-92). Many of these experiments were conducted from the mid 1960s to the early 1970s. However, in 2004, Morey and Cowen conducted experiments on visual tasks (as opposed to verbal tasks), which showed that visual tasks were significantly more negatively affected by verbal rehearsal aloud for a list of digits that were to be remembered than by silent articulation of to-be-remembered digits (706-10). An additional interesting point is that, of the subjects that had correct and incorrect responses to the digit recall, their performance on the visual recall was better when their recall of the digits was correct than when they incorrectly recalled the digits (Morey and Cowen 706-07).

Considering the results of this study, it is possible that those subjects who were better able to construct a coherent meaning from a combination of the visual and aural data were able to maintain their memory more accurately or cue recall of items more successfully.

One strategy for maximizing memory is Miller's concept of "chunking" where items are grouped and given meaning so that a list of twenty digits might be turned into two telephone numbers or a series of four-digit combinations that signify dates or years. Miller notes the distinction between "absolute judgment," which is limited by the amount of information and "immediate memory," which is limited by the number of items (92). In this classification, he distinguishes between "bits" of information and "chunks" of information, such that "the number of bits of information is constant for absolute judgment and the number of chunks of information is constant for immediate memory" (Miller 92-93). The strategy of "chunking" is most useful when the groups or chunks hold meaning for the person so that long-term memory takes on some of the cognitive load, freeing up short-term or working memory to handle other tasks (Mayer 24-25). Understanding how significant the application of meaning is to memory reinforces the need for schemas that can be used as a foundation for further learning. Interestingly, Miller further distinguishes the idea of organizing information and grouping by discussing the issue of recoding (93). He discusses recoding as a means of chunking data into meaningful groups. This idea will be discussed further in the section on multimedia, symbol systems, and recoding.

Researchers have proposed many models in order to explain the process of how sensory input becomes a thought or memory. Donald Broadbent, in 1958, proposed a single-channel limited capacity model. Input goes through the senses, into short-term memory, through a filter where selection of items to be attended to is handled, and then the selected input is given attention. Allan Paivio's work (especially from the mid to late 1960s) led to what is known as the

"dual coding" theory. In his theory, Paivio asserted that declarative knowledge is stored in both linguistic and non-linguistic forms in long-term memory. This means that declarative information can be stored and manipulated as symbolic representations, rather than strictly in verbal format (Marzano 575). Paivio's investigations went against the established methods in arguing that "the eliciting question and the behavioral expression of recall may be entirely verbal, but the mediating mechanism apparently is not" (Paivio 241-42). Paivio suggested that the concern of behaviorists that there was no one-to-one relationship between imagery and a related mental process should only be considered a valid argument if there existed a one-to-one relationship between verbal responses and mental process (Paivio 242), which he argued there was not. This theory of the lack of a one-to-one relationship has also been explored by Roland Barthes, Gavriel Salomon, and others. It is a key factor in the premise and design of the research for this dissertation. If no single word or image leads explicitly to a single meaning, but either can be a system for encoding and communicating ideas, then informationally equivalent text and images should be interchangeable, within the constraints of symbol systems, which will be explored later.

Through a variety of experiments, Paivio and his colleagues proved that, even in a verbal association system, mental imagery was at work making associations. Even using pairs of abstract terms, which were generally assumed to be more heavily verbally associative, the imagery group performed as well as the verbal group (Paivio 250). For Paivio, this undeniably proved that imagery was a viable tool in learning and memory (254). He emphasized that imagery is essentially a parallel processing system and spatially situated while verbal symbolic systems are sequential in nature but could be processed in parallel with imagery (Paivio 257). Paivio's work was a key turning point in research on cognition models.

In 1986, Alan Baddeley and Graham Hitch developed an early model of working memory, which places a "central executive" module in the middle while on one side is the "visuo-spatial sketch-pad" and on the other side is the "phonological loop." The visuo-spatial sketch-pad and the phonological loop have a bi-directional relationship with the central executive where sensory information from the environment is fed in, and information and existing knowledge that relates is sent back out (Baddeley 154). These three components were suggested as the division of labor in short-term memory. This model was modified in 2000 and now includes a third component, the "episodic buffer." Also included is interaction by the three components with long-term memory stores, including visual semantics, episodic long-term memory, and language—in addition to the bidirectional interaction of the three with the central executive (STM) as shown in Figure 1. A very thorough explanation of the history of both models and their development is available in the 2003 article "Working Memory and Language: An Overview" by Alan Baddeley (190-96).

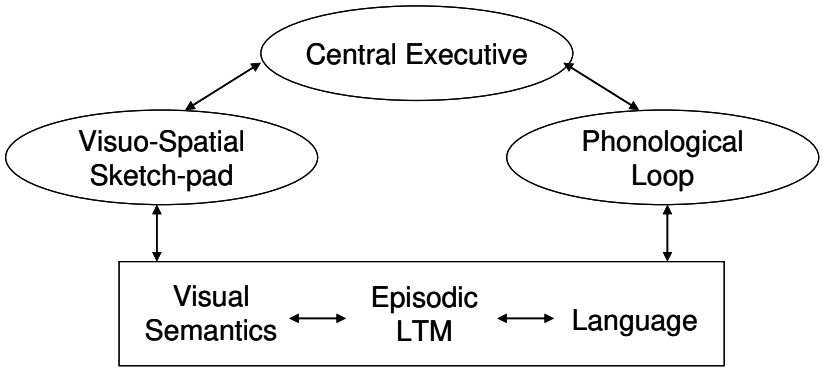


Figure 1. Alan Baddeley's revised model of working memory (modified in 2000) shows the new information in the Visuo-spatial Sketch-pad and Phonological Loop, being controlled by the Central Executive, while associations are made in with long-term memory storage.

Wolfgang Schnotz and Richard Mayer each offer dual processing models with separate entry corridors for visual and auditory input, which is processed in working memory with input from long-term memory. The key difference between the two models is that while Mayer's 2005 model continues the segregation of verbal and visual components through working memory where separate verbal and pictorial cognitive models are constructed, the 2003 model by Wolfgang Schnotz and Maria Bannert allows for crossover of sensations during processing. The Schnotz and Bannert model also uses the categories of "propositional representations" (non-tangibles, concepts such as justice) and "mental models" (spatial relationships, constructions) to denote the cognitive models constructed, which interact with and are integrated into long-term memory (Schnotz and Bannert 145). In particular, Schnotz and Bannert question the segregated nature of the parallel text processing and picture processing in the Mayer model. They argue that text and images use different sign systems where descriptive text consists of symbols describing an object, and the images are depictive using an iconic or relational symbol system from which the "reader" or decoder draws inferences (Schnotz and Bannert 142-43). See the comparison below of Mayer's model (Figure 2) with Schnotz and Bannert's model (Figure 3).

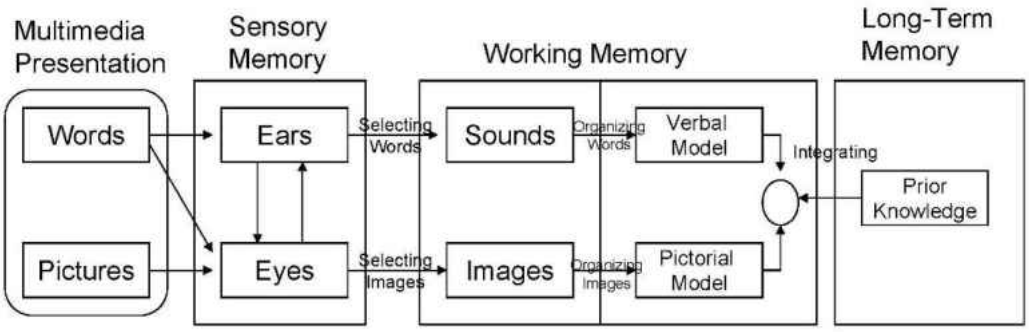


Figure 2. Mayer's model. Note the segregation (along the top and bottom channels) of visual versus auditory/textual information flow through the modalities, keeping them separate until they are integrated with prior knowledge (Mayer 37).

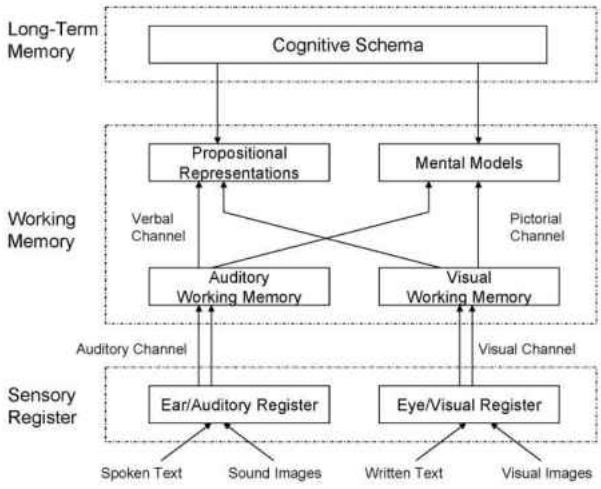


Figure 3. Schnotz and Bannert's model. Note the crossover in Working Memory between the modalities, which allow for a more categorical compartmentalization of information (Mayer 57).

The processing structure proposed by Schnotz and Bannert is similar to Paivio's in that they see both imagery and textual processing as dual in nature, such that images are associated with words and descriptors while words are transformed into images for association and meaning making (Schnotz and Bannert 147; Paivio 242). Schnotz and Bannert also argue that informational equivalence (descriptive text that details a visual image or vice versa) does not equal computational efficiency and that some information is better received and processed in a particular format or that an informationally equivalent format can be difficult to decode or understand when designed poorly (148). In other words, just because the image and the text give the same information does not mean that the viewer or reader will process them with equal success.

The development of language skills, along with the visual association between written symbols and speech required for reading, are explored in the next section. Developmental psychology and the study of the cognitive processes involved laid the groundwork for a renewed focus on the pedagogy of reading and comprehension.

Developmental Psychology and Its Impact

Starting in the early 1920s, developmental psychologists, Jean Piaget and Lev Vygotsky began contributing heavily to the field of psychology. Piaget came to the field of psychology from a background in biological study. He preferred the compartmentalization of organized structures and felt that human development followed a particular path, with identifiable signposts. He observed that "right" or "wrong" answers in psychological studies were less interesting than patterns of answers and the implications of cognitive processes. This insight led to his study of children and the stages of cognitive development. In his book, *The Psychology of Intelligence*, Piaget notes, "Gestalt theory, although correct in its description of forms of equilibrium or well-structured wholes, nevertheless neglects the reality, in perception as in intelligence, of genetic development and the process of construction that characterizes it" (66).

Using constructivism as his guiding principle, Piaget worked through an astounding number of formulations regarding the progressive development of perception, cognition, and awareness. In distinguishing between perception and intelligence, Piaget described perception as a system of interdependent relations. He noted that structures in perception are intransitive, irreversible, and "not composed in accordance with laws of grouping, the reason for this being that the distorting relativity that is inherent in them gives them an essentially statistical nature" (78). In other words, Piaget's view corresponds to James's idea of a sketch or an echo of an

impression. Intelligence, on the other hand, is constructed of a logic that is reversible, and where in the comparison of one object with another, neither the standard nor the object measured is distorted by the comparison. It is constructed of facts or components that can be manipulated and tested.

Piaget also stated that sensorimotor intelligence was the source for thought and allowed for intelligence to be constructed from trial-and-error activities (105, 119). This is the first stage of development from 0 to 1 ½ years old. With the onset of language, the development of pre-conceptual thought begins. This stage lasts through the age of 4 years and is distinguished by the internalization of this trial-and-error scenario. Development of apparent intuitive thinking happens between the ages of 4 and 7 or 8 years. From the age of 7 or 8 up to approximately 12 years old is the stage of "concrete operations" where systems are grouped organizationally. Beyond that, formal thought develops, along with the ability for abstracted thinking (135).

According to Piaget, all thought processes, cognitive processes, and motor activity consist "…in linking meanings, and all meaning implies a relation between a significant and a signified reality" (124). The forms of the significant and the values of the signified are dictated by social factors. Piaget writes, "social life affects intelligence through the three media of language (signs), the content of interaction (intellectual values), and rules imposed on thought (collective logical or pre-logical norms)" (156). Again, this reinforces the importance of the construct of schemas and the need to be aware of the social background in which they have been developed when working with students. The work by Piaget and Vygotsky on early childhood development is the cornerstone of modern educational theory and is regularly referred to today.

For Lev Vygotsky, the important fact that natural development and cultural development do not coincide was the key to many misunderstandings of cognitive function. He felt a new

approach was needed to focus on higher mental functions, cultural development, and mastering one's own behavioral processes (Vygotsky xxix). As noted in the introduction by Alex Kozulin, Vygotsky's goal in writing *Thought and Language* was to show that natural and cultural development had different roots and only converged at a certain moment in development, after which they develop together each under the reciprocal influence of the other (xxxi). Vygotsky argued that the progress in thought and progress in language are not parallel and that the relationship is not an unchangeable one (68). He notes that the development of speech, along with other mental operations that involve the use of signs generally progresses through four stages. The first stage is primitive or pre-verbal thought. The second is akin to sensori-motor, where the child physically experiences the world around him and begins to use tools, which is defined by the use of grammatically correct speech structures. Thirdly, distinguished by the use of external signs, is when the child counts on his fingers, etc. The final stage is the internalization of these operations, accompanied by the use of logical memory and inner speech (Vygotsky 86-87).

Vygotsky also argued that the external process of speech progresses from a single word to groups of words to sentences, while semantically, the process was reversed, noting that, for a small child, a single word contains the entire meaning of the thought (218-19). This again demonstrates the lack of a one-to-one relationship between signifier and signified. For a child who is hungry and wants to eat an apple, the goal is clear. However, an older child is able to express himself in a more complex and subtle manner with a variety of words and word combinations, while a younger child might encapsulate the entire thought into the single word "apple." For Vygotsky, in order for communication to occur, thought must pass through

meaning, and then meaning must be relegated to words (252). He believed that "[t]hought and speech turn out to be the key to the nature of human consciousness" (256).

Additionally, Vygotsky formulated the idea of the "zone of proximal development." Children were given problems beyond their ability and given some form of assistance (the first step, a leading question). Some children, given assistance, could solve problems designed for twelve-year-olds, while others could not go beyond those for nine-year-olds. Vygotsky writes, "The discrepancy between a child's actual mental age and the level he reaches in solving problems with assistance indicates the zone of his proximal development" (187). This discovery is a better measure of a child's ability than intellect alone and is a strong indicator of how well the child will perform in school. Vygotsky noted that an analysis of the data showed that with the proper curriculum and supplies, "the development of scientific concepts runs ahead of the development of spontaneous concepts" (190). This idea is a key construct in the formation of the premise of this research topic. Later, in the section on Content Learning, I will discuss an analogous concept, "Zones of Learnability." This is an experimentally proven concept that the ability to learn new content is contingent on the amount of existing knowledge in relation to the amount of novel material presented.

Summarily, in this section, I have discussed the theories in the field of psychology that have been put forth in order to understand how our minds process information and make meaning. The models proposed to conceptualize how memory functions have evolved into more complex models designed to elucidate the cognitive digestion of verbal and visual input. Along with the theories and research in the area of childhood development, these schematics of our mental circuitry help formulate opportunities for research into these phenomena. The next step is to investigate specifically the development of language skills and the impact and implications of

those skills in the reading process. The following section explores how children compile, process, and formulate the use of language.

Language Acquisition

Vygotsky argued that thought and language stem from different roots, merging at a certain point in development so that they were often indistinguishable (xxix). It is known that infants prefer the sound of human voice over other noises and that by the age of six months, they can distinguish sounds (such as the difference between a ‘b’ sound and a ‘p’ sound) at the same voice onset time as adults (Siegler, DeLoache, and Eisenberg 224). Many linguistic accomplishments are achieved in the first eighteen months, including the ability to distinguish between native language sounds and non-native sounds, recognition of words, patterns of sounds and cadences, and the ability to form syllables and sounds from their native language (Siegler, DeLoache, and Eisenberg 224). Also, during this time, other systems are developing, including sensori-motor skills, such as grasping, pulling, crawling, and walking, along with the environmental awareness of object orientation, basic laws of physics (solids do not pass through solids) and so forth. Through the age of five years, early language development moves through the stages of the holophrasic period where a single word contains all the meaning, to multiple words, to sentences. Thought processes develop rather in reverse, moving from a single concept, where the entire thought is encapsulated in a single word, to the point where multiple words hold meaning. Finally, sentences are formed where meaning can be manipulated by changing the words or word order. Somewhere during this period, thought and language merge.

The ability of children to learn languages and absorb grammar structure during this developmental period has been shown to taper through the age of about seven and to sharply

diminish from then through puberty. This critical period of language acquisition was first proposed by Eric Lenneberg in 1967 in his book *Biological Foundations of Language*. Lennenberg argued that the window of language development for humans (along with other psychological capacities) is controlled by an innate biological trait (174-75). Much of the mental construct of brain function and the "wiring" of cognitive structure are dependent on the early and appropriate acquisition of language skills. One theory for the success of this window of language development is that a small child's world is not as complex as an adult's, and meaning and sentence structure can be simplified to match cognitive ability.

It is important to remember that language comprehension precedes language production, but that by the age of five years, most children have mastered the basic grammatical structure and a vocabulary of several thousand words (Siegler, DeLoache and Eisenberg 214). As development progresses, many skills, such as counting, thinking aloud (self-talk), and strategy (trial and error), are internalized. In addition, Robert Marzano notes that language also acts as a "mediator of cognition" in such situations as learning a complex skill. Actions are mediated by language (self-talk) until the skills are sufficiently developed and automated (Marzano 561). Thought and language merge into a symbiotic relationship.

Paula Menyuk notes that language is generally seen as "an arbitrary symbolic system composed of units at different levels, which are embedded into each other" (24). Components or units consist of "words, utterances, and discourse" (Menyuk 24) and are combined and recombined to create new or different meanings. Menyuk notes that children acquire language as a collection of parts and a set of rules for combining those parts, making language acquisition generative, rather than memorization (24-25). Understanding the phonetic structure of these sound units is the key to the transition from speaking to reading. Strong language skills,

particularly phonetic and graphemic awareness, are especially important in the development of reading skills (Rayner and Pollatsek 332, 344, 351; Siegler, DeLoache, and Eisenberg 318).

Reading

Children do not learn to read in the same manner that they learn to speak. Reading is a contrived system of symbols that must be decoded before they can be processed. Early development in reading skills has been related to a strong phonological awareness (Stothard and Hulme 102; Rayner and Pollatsek 344; Siegler, DeLoache, and Eisenberg 318; Underwood and Batt 13). Keith Rayner and Alexander Pollatsek note four particular levels of reading development. The first is "linguistic guessing" where children base their judgment of a word on the first letter or two and story context. The next is "discrimination net guessing" where consideration is given to the first and last letters of a word, the word shape, length and basic physical features. Third is "sequential decoding" when children apply the rules of phonics and the symbol system to work out an unknown word phonetically. Fourth is "hierarchical decoding," which builds upon sequential decoding by adding sophisticated phonetic rules such as "c" is the same sound as "s" when before "i" or the same as "k" when before "o" (Rayner and Pollatsek 360-62).

Philip Gough, Wesley Hoover, and Cynthia Peterson suggest that it is not the sum of decoding and comprehension that create reading; rather, the relationship is multiplicative. If either decoding or comprehension is near zero, then reading does not occur (Gough, Hoover, and Peterson 3). In order to analyze reading as a skill, it is necessary to look at decoding and comprehension issues separately.

Decoding

Once decoding skills are established, the process becomes fairly automatic. But, how are they established? Words are not processed letter by letter, and, in fact, letters become more easily recognized in the context of a word than in isolation (Underwood and Batt 12). This is known as "word superiority." An example that shows the automaticity of word recognition is a phenomenon known as the Stroop effect. In this test, various words are shown in a colored ink. The goal is for the subjects to name the ink color as quickly as possible. When words, such as "truth" or "tractor," are presented, naming the ink color is very quick with minimum errors. However, when the word is an interfering word, such as "red," and the ink color conflicts, such as green ink, the automatic processing of the word interferes with the naming of the ink color. This is shown in slowed response times, as well as errors (Underwood and Batt 30-31; Rayner and Pollatsek 62-69). Familiarity also plays a part in decoding such that words that are more frequently encountered are recognized and processed faster than unexpected or less frequently used words, while words that have been recently viewed are processed significantly faster on subsequent occurrences (Underwood and Batt 49). For this dissertation, subjects will be well below grade level for reading but will not be at the level of phonetic or decoding inadequacies. It is a goal of this research is to investigate a method designed to improve vocabulary acquisition by facilitating comprehension.

Comprehension and Content Knowledge

Along with decoding, content knowledge is the key to making meaning out of combinations of words. Marjorie Hancock suggests there are five building blocks of reading: phonemic awareness, phonics, fluency, vocabulary, and comprehension (133-34). She explores

comprehension further, stating that it is the ultimate reason for reading, and several skills are required for strong comprehension. As Vygotsky commented, words without meaning are merely sounds and, therefore, no longer meet the criteria of what is meant by "word" (212). However, Holbrook Mahn and Vera John-Steiner note that Vygotsky qualified meaning with:

> Meaning is not the sum of all the psychological operations which stand behind the word. Meaning is something more specific—it is the internal structure of the sign operation. It is what is lying between the thought and the word. Meaning is not equal to the word, not equal to the thought (Beach, et al. 80).

This corresponds to the assertion by Paivio that the input and output of an exchange might occur verbally, but that the mediating processes were not necessarily verbally structured (Paivio 241-42). Hancock implies that comprehension is an active pursuit, using terms such as "activating" prior knowledge, "monitoring" comprehension, "using" graphic organizers, story frames, and concept mapping (137). She also stresses the importance of using mental imagery and visualizing characters and settings (Hancock 138).

Content Knowledge

Content knowledge comes from the schemas and frameworks built up over time in long-term memory stores. Schemas are ideas of situations, locations, or items that are grouped together mentally. People organize everything they know into schemas or knowledge structures (Marzano 560). These would include such references as "restaurant" where a reader, when reading that the couple met in a quiet little café, would call upon all the related information in that schema, such as booths and tables, tablecloths, waiters, menus, flatware, etc. (Rayner and Pollatsek 265). These conceptual worlds are built around personal experience but are also

influenced by society, cultural norms, movies, or television depictions and practically all other forms of input (Tracey and Morrow 51). A child who has never been to the beach has very likely seen pictures or movies from that region and the level to which this schema adds meaning to the author's words will be a function of the fullness of those references. Diane Tracey and Lesley Mandel Morrow suggest that schemas can be altered through three processes: 1) accretion, where new information is taken in but does not require altering an existing schema, 2) tuning, where a schema is modified to incorporate new factors, and 3) restructuring, where a new schema must be created because an old schema is no longer sufficient and cannot be acceptably modified (52).

This concept of the reader's schemas "filling in the blanks" is relied upon by the author, and it personalizes the reading experience for the reader. Louise Rosenblatt in *The Reader, The Text, The Poem: The Transactional Theory of the Literary Work* argued that reading is a "transactional" experience. It cannot be decided purely from the author's intent because each reader brings her own personal experiences, preferences, and social background to the event (11). Rosenblatt argued that, at the point of the act of reading, all that is left is the text and the reader (20). The author is no longer involved. The issue is what the reader brings to the experience and the reader's ability to navigate and make meaning of the text presented (Rosenblatt 54). In a way, the author could be seen as giving a list of ingredients, but it is up to the reader to understand and decode the ingredients and to combine them into a meaningful dish (Rosenblatt 49). The decoding of the ingredients and the referential frameworks used to make meaning of them is called cognitive processing.

Comprehension

Several models for cognitive processing have been proposed to make sense of the mental pathways that move words on a page through our cognitive constructs and create understanding and imaginary worlds. I believe that the best model of cognitive processing must account for the ability to process various types of input and turn it into a mental model that either fits into an existing mental schema or is used to modify the schema appropriately. Donald Leu, Jr. and Charles Kinzer offer a hierarchy of components for reading that are structured, from the bottom up, in the order of 1) decoding knowledge, 2) vocabulary knowledge, 3) syntactic knowledge, 4) discourse knowledge, and 5) metacognitive knowledge. These lower five are hedged on either side by "automaticity" and "emergent literacy" while the top tiers are 6) affective aspects and 7) social aspects. Leu and Kinzer agree with Vygotsky's earlier assessment that the social context established for reading at home, at school, and by society in general plays a significant part in reading comprehension and personal involvement (64-65).

Higer-level readers build spatial models of environments described by text, such that the orientation of characters and environmental items are formed, and recall of the relationship of those items can be constructed without specific recall of whether the information came from an image, description, or if an orientation was given explicitly or implicitly in the text (Kintsch 191, 223). When there is a breakdown in the system of cognitive model formation, then comprehension is compromised, and "reading" cannot occur. In a 1995 study conducted by Susan Stothard and Charles Hulme, students with "poor" decoding skills were found to have age-appropriate IQ scores and age-appropriate listening comprehension but severely impaired phonological skills (103-7). With regard to the task of cognitive processing, word recognition for most readers is automatic, which leaves the cognitive capacity free for mental model formation

and meaning making. By shifting the cognitive load of attention and awareness to the process of decoding words, the ability for reading fluency such that several words are read and analyzed for relational meaning has been crippled.

Looking at the issue of comprehension, in an earlier study conducted by Stothard and Hulme in 1992, students with "poor" reading comprehension were matched by age to a control group for the same age and normal achievement as well as being matched by achievement level with a control group of younger students and normal achievement. The "poor" comprehenders had age-appropriate IQ scores, but verbal IQ scores and listening comprehension were closer to the younger control group. The "poor" comprehenders' phonological skills and spelling skills were also similar to the younger control group (Stothard and Hulme 96-102). Thus, the experimental group had appropriate comprehension for their verbal and phonological ability—unfortunately, the development of all of these skills was significantly behind their age group peers. The lack of appropriate grade level comprehension often leads to the student falling behind in topics other than reading due to their inability to decode and comprehend the materials. It is a dangerous, downward spiral that requires early intervention.

Kate Cain's 1996 study of reader comprehension in stories with images versus stories without images showed that images were most useful for "poor" comprehenders (178). However, this study was also interested in the metacognitive awareness of story structure and comprehension. Other interesting results showed that "poor" comprehenders benefitted significantly from a story title that was descriptive and contained action words rather than an abstract title and showed that "poor" comprehenders did not make appropriate use of cues in the beginning of stories to detect setting or time and spatial orientation of the story (Cain 183-84). The researcher suggests that knowledge of story structure is more likely the cause of reading

comprehension issues rather than the result of such issues (Cain 189). As noted by Glenda Gunter and Robert Kenny, story has a powerful effect on cognition, providing a means of situating information (41). The use of story as an informational organizer also allows for better retention of information (Gunter and Kenny 41).

These studies have led to the development of models used to examine the process of reading. Noting the impact of components such as I.Q., language development, listening skills, and mental model formation is only the beginning. Identifying the interactions of these components allows for the study of the process of reading and the identification of specific issues of interest when the process is not successful. The following section looks at the evolution of models of reading over the years and their impact in this field.

Models of Reading Processes

Models for reading and speech have evolved subtly. The Morton model of the logogen system in 1969 allowed for two inputs, auditory and visual. These were then processed in the logogen system with feedback from the cognitive system, fed into a response buffer, and finally output into a response (Underwood and Batt 48). In 1980, this model was modified with separate logogen systems for each of the auditory and visual channels (see Figure 4). Also added was a grapheme/phoneme converter, which worked with the visual input. Further fine-tuning included an output logogen system before the response buffer and a channel from the auditory logogen system that bypassed the cognitive feedback and went straight to this additional output process (Underwood and Batt 53).

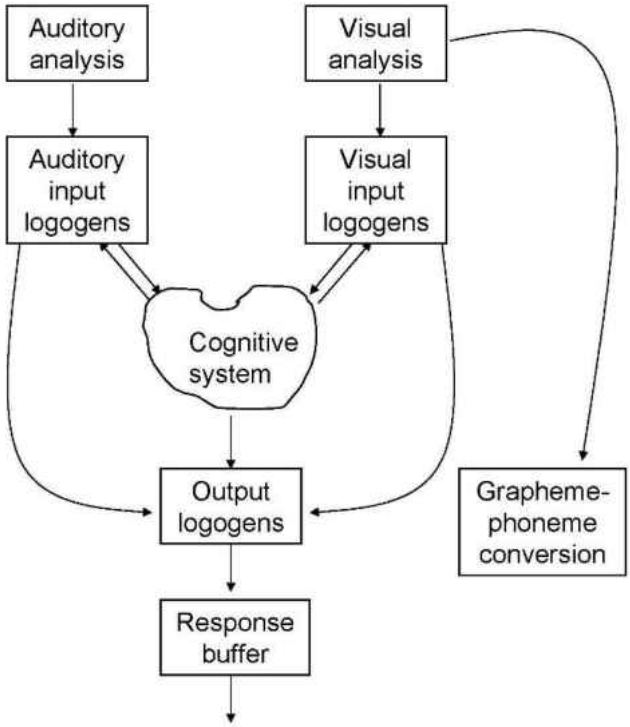


Figure 4. 1980 version of Morton and Patterson's logogen system (Underwood and Batt 53).

In 1981, Max Coltheart suggested the Dual-Route model of reading. Printed text is processed through visual feature extraction, then abstract letter identification, at which point the model divides into two routes, one side being the orthographic word recognition, via a semantic processing module to word production, to speech. There is also a bypass such that a reader can progress from the orthographic word recognition directly to word production, such as when a word can be pronounced, but the meaning is unknown. The other side starts with graphemic parsing, through phonemic assignment, through a blending module and then to speech (Underwood and Batt 120).

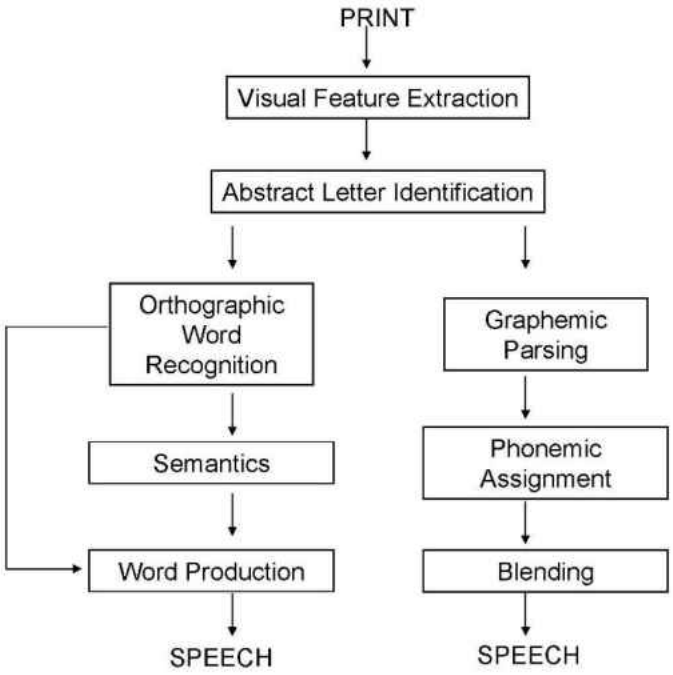


Figure 5. Coltheart's 1981 Dual-Route model of reading (Underwood and Batt 120).

In the Parallel Distributed Processing (PDP) model of reading, designed by Mark Seidenberg and James McClelland in 1989, the information from the text enters into the system by "orthography" and/or by "phonology;" the processing is bidirectional with "meaning," which has a bidirectional connection to "context" (Underwood and Batt 125). The PDP model was heavily influenced by distributed representation models of James McClelland, David Rumelhart, Geoffrey Hinton, Max Coltheart, Robert Glushko, and John Morton.

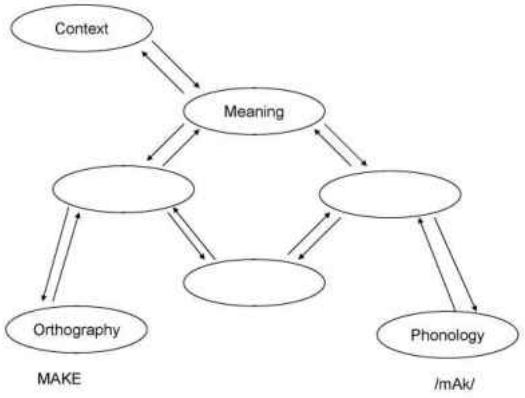


Figure 6. Parallel Distributed Processing (PDP) model of reading, designed by Seidenberg and McClelland in 1989 (Underwood and Batt 125).

These models of reading follow the theoretical models of cognitive processing using dual routes mentioned previously. This system intuitively makes sense if you consider the situation of a literate person who sees an aurally familiar word for the first time in print, possibly a word adapted from a foreign language so that it is spelled in an unexpected way—such as "faux pas," which needs to be "run through" the cognitive system aloud or the expected visual symbol decoding needs to be adjusted to the foreign phonological coding. Strong readers are accustomed to making such adjustments and have the broad range of comprehension tools available to build meaning out of such coding systems. The PDP model and earlier studies agree that cognitive load used for decoding and meaning making lessens cognition available for comprehension and higher order processes (Tracey and Morrow 168).

In 1993, Coltheart and colleagues revised the dual-route model to a more integrated system called the Dual-Route Cascaded model (see Figure 7 below). Computer testing of this model has shown promise. The network was able to learn the grapheme-phoneme

correspondence (GPC) rules from exposure to 2,897 words (the same set used in testing the 1989 PDP model of Seidenberg and McClelland) (Underwood and Batt 126-28).

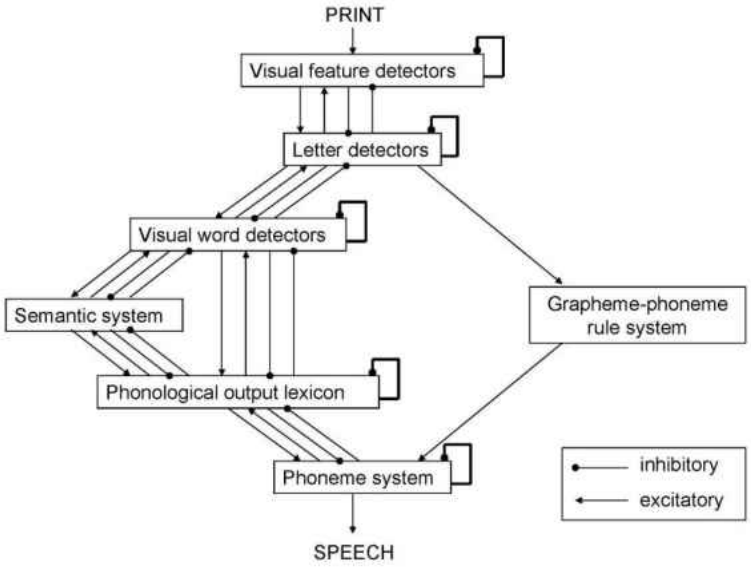


Figure 7. Coltheart's Cascaded Dual-Route model (Underwood & Batt 129).

Keep in mind that the main purpose of all these models and computer testing is to try to understand how the human mind processes language so skillfully. Basically, organizational systems and flow diagrams are being designed and tested because the incredible complexity of the human mind and its adaptability make it very difficult to trace exactly how we know what we know. The excitement of teaching a computer system a sample vocabulary of approximately 2,800 words and then having the model correctly assign pronunciation rules to non-words does not compare to watching the excitement of a four- or five-year-old child who has just read her first words and had the meaning blossom into pictures in her mind. But, having these models can

help us understand how the process should work and make inferences about what went wrong when the system fails.

Along with models that can help us understand the reading process, computers and electronic media have brought about the need for interpreting a variety of mediums and symbol systems blended together. The presentation of words (printed or spoken) and images (moving or still) together is considered multimedia. The following section defines and evaluates the cognitive processes involved in properly and efficiently interpreting such communications.

Multimedia, Symbol Systems, and Recoding

Multimedia is defined by Mayer as presenting both words (in spoken or printed form) and pictures (still images, animations, or video) (2). Learning is defined as a change in long-term memory (Mayer 20-21). Therefore, multimedia learning is the presentation of words and images that create or forge a change in long-term memory. Clark and Mayer note that people generally learn better from pictures and text than from text alone (68). Gunter and Kenny suggest that even seeing the movie version of a book first, then reading the book, may allow students to call on the visuals from the movie in constructing their visualization of characters, actions, and settings (42). Content knowledge weighs heavily on the side of comprehension, but sometimes the effort to wade through the unfamiliar terms can wear down a "poor" reader (Stothard and Hulme 98). This dissertation proposes that an alternative is to present descriptive and depictive text as a visual image, along with the action or event text, much like the images of the models on the preceding pages help clarify understanding.

At this point, I'd like to revisit the idea of "recoding" mentioned by George Miller in his paper, "The Magical Number Seven." Miller uses the example of a beginning telegraph operator

learning Morse code who initially struggles to track each dot and dash, order them into a meaningful sequence, and translate. However, soon, groups of dots and dashes hold their own meaning as letters and even in combinations as words (Miller 93). This is very much like learning to read, moving from phonetic sounds, to groups of sounds associated with the letters, to automatic word recognition. My point of interest is with a study Miller mentions where test subjects were briefly taught binary code and then given several digits (in binary groupings), with the expectation that translating the original eighteen digits into variations of recoding (from a 2:1 exchange all the way to a 5:1 exchange) would enhance recall (Miller 93-94). The improvements in recall were not as great as expected, especially with the higher (4:1, 5:1) recoding ratios. It was reasoned that this short training period was not sufficient and that the translation from one code to another needed to be automatic or instantaneous to avoid affecting the memory rate (Miller 94). This idea, from 1956, that recoding, in order to be effective, needs to be instantaneous further convinces me that the use of images to aid in the recoding process for low-level readers can significantly impact cognitive load required for de/recoding and allow more resources to be allocated to comprehension.

For some, the availability of multiple mediums for the transmission of information leads them to the intuitive approach of presenting the information in as many ways as possible in order to "hit" a cognitive sticking point so that the information will be transferred to knowledge. Beyond showing no learning gains, this approach is actually counterproductive and has a negative affect on learning (Mayer 162; Clark and Mayer 117). This is known as the Redundancy Principle (Mayer 159). It overloads cognitive processing. Instead, the most direct route is to provide stimulation in the form of words and images (multimedia principle) in such a manner as to make them easy to hold in short-term memory (the segmenting principle, much like

"chunking"). The content should be such that some overlap in long-term memory exists to facilitate making connections to existing schemas, with as little redundancy between images and text as possible to minimize cognitive load (the redundancy principle) and enhance the ability of working memory to make meaningful connections and transfer the input into long-term storage (Mayer 6).

Viewed from another direction, each of these presentation methods or mediums can be seen as a particular symbol system, requiring a particular set of skills to "recode" and comprehend. Tracey and Morrow, as well as Hickman, discuss Vygotsky's insistence that children learn as a result of social interaction with others and that this development of communication skills depends on the sign systems with which individuals grow up (Tracey and Morrow 108-9; Hickman 12-13). It has been suggested that for Jean Piaget, language development was one component for cognitive development, while Vygotsky considered language as the symbol system that acts as the mediating organizer of sensori-motor activity, personal interactions, and the acquisition of environmental knowledge for the developing child (Hickman 13, 17-18).

Both Piaget and Vygotsky acknowledged the power of language as a sign system. Salomon has expounded on the concept of symbol systems in communication, beyond the strictly alphabetic and phonetic structure. For Salomon, every form of media consists of a specialized set of symbols that are used to communicate in particular ways and involve specific cognitive skills for recoding and comprehension (xix). Salomon argues that, "the three most typical assumptions about media (their invariant natures, their role as alternative means to the same ends, and media research as the basis for selection decisions) are wholly or partly invalid" (13). He states that

technology, in and of itself, does not directly impact learning but interacts with the learning process due to the symbol systems used by particular mediums (Salomon 19).

Symbol systems are interpreted using specific syntactic rules and conventions and vary in the level and types of cognitive processing used for comprehension (Salomon 20, 64). Salomon uses Elliot Eisner's argument that each symbol system is constrained by what can be conceived and expressed within its unique medium but moves beyond the comparison of painting versus poetry and includes television, film, still and moving images, along with iconic writing and combinations thereof (65). He defines a notational system as one where both the system's elements and its referents are separate and able to be manipulated with a one-to-one correspondence. Due to the ambiguities of language, it is only partially notational. Pictures are considered non-notational because no particular image or element can be unequivocally representative of only a specific referent (Salomon 33). Salomon concedes that language allows conditional states to be made known (e.g., if, might, possibly) (66), but that the comprehension of text is "assumed to be aided by the generation of imagery-like meanings" (70). He also suggests that providing a learner with ready-made supplements (whether text for a verbally weak learner or images for a visually weak learner) improves learning by improving comprehension and reducing cognitive load (Salomon 66, 70, 72).

Non-alphabetic, visual communications systems have existed for thousands of years. In "Print Scholarship and Digital Resources," Claire Warwick recalls her trip through a Byzantine museum and the tutorial she received on how to "read" the Greek artifacts. The symbols and colors in different patterns all combined to lead to communication and meaning in a non-textual narrative (Schreibman et al. 367). Suzanne Langer argues that visual forms are just as capable of "articulation" as words; however, visual forms are not "discursive" but offer a simultaneous

presentation of information (93). Roland Barthes discusses the correlation of images and text and suggests the there are two specific relationships between the two. “Anchorage” is defined as words accompanying an image that have the function of denotating or locating the image. “Relay” is when a word and image each contribute separate but related units to a single syntagma (Barthes, “Narratology” 38-41).

It can be argued that we think in images and apply language as a means to conveying those images to the minds of others. This argument is supported by the development of such scientific concepts as electromagnetic fields, proposed by Michael Faraday in the mid-1800’s, but only mathematically proven by James Clerk Maxwell after Faraday’s death. This proposition and the mental visualization necessary to its development has been noted by Salomon in 1994 and again in 2000 when in *The Language Instinct: How the Mind Creates Language*, Steven Pinker writes:

> Michael Faraday … had no training in mathematics but arrived at his insights by visualizing lines of force as narrow tubes curving through space. James Clerk Maxwell formalized the concepts of electromagnetic fields in a set of mathematical equations and is considered the prime example of an abstract theoretician, but he set down the equations only after mentally playing with elaborate imaginary models of sheets and fluids. (Pinker 66, also noted in Salomon 71-72)

Pinker also suggests that authors often start with mental images of the story and then choose the words appropriate to convey those images to the reader. For this research topic, the question of how imagery and text interact and affect learning is of primary interest.

If neither images nor words have a one-to-one relationship between signifier and signified, then it seems valid to argue that content learning and comprehension can be achieved using either or a combination of both. It is known that comprehension and learning can be better achieved by using an appropriate combination of images and text, rather than text alone. The goal of this dissertation is to show that by using a combination of images and text, reading ability can be improved by facilitating appropriate schema development and vocabulary acquisition.

Content Learning and Classification

Salomon states that, while familiar objects are not impacted during classification tests by the medium in which they are presented, classification of unfamiliar objects is heavily influenced by the medium (80). He suggests that this is due to the amount of cognitive effort required for mental translation, and the cognitive skills required for comprehension (Salomon 217). Prior knowledge of a subject plays a huge part in comprehension and learning. Walter Kintsch developed "zones of learnability" analogous to Vygotsky's "zones of proximal development" (Kintsch 323). If a student's knowledge overlaps too much with the instructional material, then there is too little room for growth. If there is too little overlap, then links for the new knowledge to connect to long-term memory do not exist. Herbert Clark and Susan Haviland call this the "given-new" contract (Rayner and Pollatsek 266-67), such that, as Diane Schallert puts it, "what one already knows influences the quantity and quality of what one can learn" (Schallert 31, 34). Michael Wolfe and co-workers, through calculations based on prior knowledge and learning, estimated that by assigning students texts based on their background knowledge, learning scores could be improved by more than fifty percent (Kintsch 327).

The teaching of content is often constructed around information, examples, and practice. John Sweller and Graham Cooper's study of the use of examples shows that using worked examples, along with practice, leads to significantly higher learning outcomes with fewer errors in less time than standard practice alone (Sweller and Cooper 59; Clark and Mayer 205-57). Schallert mentions this technique as a classroom-teaching tool such that the teacher initially performs nearly all aspects of a reading task, gradually withdrawing and having the student take on more and more duties, until the student is successfully completing the task on their own (36-37). This process is called "fading." Putting this principle to use with poor readers as a potential learning method, it seems logical to replace a significant portion of the text with visual images that are informationally equivalent but possibly comprehensionally superior for low-level readers, with continually fewer images and more text until the majority of the information has "faded" to print with a minimum of visual images. In the previous discussion, it has been noted that reading comprehension is the building of mental images and representations. Students who lack the skill of translating words on a page into spatial images or abstract representations can benefit greatly from explicit practice of these skills, including drawing the setting of a story or mapping out the movements of a character. Students may be aware of cultural norms and practical information in visual format, but not know the vocabulary to describe it. Working in this way, meaning can be drawn from both the words on the page and the visual context.

Purpose of This Study

Combining knowledge from the historical study of language acquisition, schema development, and reading as the multiplicative combination of decoding ability and comprehension would seem to lead to the idea that presenting low-level readers with texts where

descriptive portions have been replaced or heavily supplemented with images should benefit learning. The theory is that presenting schema "templates" or "building blocks" in the form of images, along with text, will lighten the cognitive load and facilitate the modification of schemas, the acquisition of vocabulary, and speed the learning process with the goal of helping students "catch up" to their expected performance level. The focus of this research is to test the validity of this concept, along with proposing the idea that "writing with images," as opposed to an illustrated text, can move significantly beyond the idea of picture books for very young children and into a viable tool for language acquisition, story comprehension, and improved learning outcomes for older students. The following chapter consists of a literature review of research and theories of particular value for the formation of the foundation of this particular study. This current study builds upon the work of researchers in the fields of education, psychology, and narratology. This study specifically gains value by combining the work from these fields, and by analyzing the results of the study by demographic breakdown to isolate particular effects for specific groups.

CHAPTER 2 – LITERATURE REVIEW AND RESEARCH PLAN

This chapter outlines existing literature and research studies that are directly applicable to this research topic in order to show what this study is designed to build upon. In addition, this chapter demonstrates how this current research plan fits into the existing body of knowledge and justifies the organization and structure of this research instrument. It is important to address some key questions, in order to ascertain definitions that can be used as parameters in this study. What is a story? How are stories communicated? How do we make meaning of communication systems and symbols? What part does phonemic awareness play in decoding? How can comprehension be measured or improved? What are the best practices that allow a reader to decode and comprehend a text? Does format matter? Does the media used for the presentation of the material play a part? All of these questions play a role in developing the structure of the study in this dissertation.

The first section describes the theoretical structure of narrative, its component parts, definitions, and other fundamental information. Later, the discussion focuses on how we read and make meaning and the science behind decoding and comprehension. The effects of cognitive load on comprehension heavily impact the design of the research instrument and the rationale behind the structure of the research study is discussed. Finally, the construction of this research apparatus is outlined with references to the research fundamentals that were integrated into the design of this study, and the justifications behind those decisions.

Narrative and Narratology

One typical purpose of a narrative is to generate a mental construct of a world or event. Bower and Morrow suggest that this construct consists of "…descriptions of the cast of characters, their occupations, relationships, and personal traits… [and] a mental map of the physical settings in which the actions occur" (44). The premise of this dissertation is that using images to replace portions of text that denote the physical settings (or descriptive imagery) reduces cognitive load for low-level readers by allowing meaning to be created from both the textual words as well as images (which act as surrogate or supplemental schemas). The implementation of the fading construct from the work of Sweller and Cooper, which was modified by Clark and Mayer, allows for more efficient learning by meeting the experience level of the readers. By this, I mean that readers with low experience are provided more images at the beginning of the book to supplement poorly developed schemas, which fades to fewer images when the reader has progressed to a higher level of experience toward the end. This process also allows the reader to gradually take on more cognitive load in assembling a higher percentage of the visualization of the story, thus allowing the reader to be more rigorously engaged. In particular, for this dissertation, I will focus on the idea of narrative and the communication of a story and how this method of transference can improve comprehension.

In the field of narratology, a narrative is described as a series of logically and chronologically situated events that are caused or experienced by actors or agents (Bal 5; Prince 4, 61; Genette 25). An event is a transition from one state to another, specifically that impacts, happens to, or is caused by an agent or actor (Ryan, "Narrative" 29; Prince 61). A narrative text is a construct that relates a story or sequence of events (Bal 5); however, that construct is not

limited to print or verbal language. A story is independent of any particular medium and can be transmitted via dance, images, or architecture (Ryan, "Narrative" 26).

Roland Barthes writes in "An Introduction to the Structural Analysis of Narrative" that "…there is not, there has never been anywhere, any people without narrative…narrative remains largely unconcerned with good or bad literature…[however]…no one can produce a narrative without referring himself to an implicit system of units and rules" (237-38). Barthes further defines these units and rules such that combinations of phonemes create words, combinations of words construct sentences and sentences are formulated into discourse. Narration is limited, however, in that it can only be interpreted or receive meaning within the constraints of the society that utilizes the story (Barthes, "Narrative" 264). The purpose of a narrative or story is to communicate a series of events to another person. To attempt to do this in a manner that lacks meaning for the recipient defeats the purpose. Although the recipient has a responsibility to work to make meaning of a communication, there needs to be a level of shared knowledge, experiences, or cultural norms in order for communication to occur. The impetus behind the research concept in this dissertation is to improve the transfer of communication by providing supplemental ways of making meaning from a text or a story.

Various Forms of Narrative

It has been well argued that a story is independent of the medium used to transmit the story. The essential construct of a story, the skeleton formation of actors, actions, and results, can be the supporting structure of a ballet, movie, play, or novel. Regardless of the medium, we follow the interactions and challenges faced by the actors. In fact, the term "story" is used to denote both the ideas being transmitted and the material form of the transmission left in writing

or art. Regardless of the material form, it is the transfer of ideas and experiences that we follow (Herman, “Cambridge Companion” 19; Helfand 107).

It is important to note that there are multiple meanings for the term “text” and several variations of “literacy” (Ryan, “Cognitive” 215). The term “text” not only includes text with images but also moving images, and soundtracks. “Literacy” includes the ability to decode page design, iconic writing, and multi-dimensional communications (Cox 13-14). There are also pedagogical issues in balancing what is possible with what is useful. Just because we are able to transform literature into a variety of mediums (or combinations of mediums) does not mean that the communication of meaning and the transfer of the story in the literature is being served by such transformation (Cox 16-17). Marzano suggests that the definition of literacy in the "low” sense means the ability to follow social norms and read and write in a manner consistent with the expectations of a society, but that in the “high” sense, literacy includes critical and creative thinking skills (571). In this vein, we can discuss the various mediums that today’s society uses to transmit stories to children.

Space and Time in Narrative

Those who love to read understand the idea of being “transported” by a story. The connection the reader has within the framework of the story is not constrained by physical location. However, the act of reading is itself situated within the physical constraints of a place and time (Bridgeman 63). A reader is physically located somewhere (in a seat, on a couch, in a plane) and requires a finite amount of real time in order to read and process the story. But, the time and space within a narrative are not subject to such constraints.

Narratives present time and space in various ways and use these elements to construct a framework for a story (Bridgeman 63; Herman, "Cambridge Companion" 161; Ryan, "Narrative" 29). An event in a story that takes up several pages could have a real-world time span of only a minute or two (Prince 26, 55; Herman, "Cambridge Companion" 162; Genette 33). Think about a story that relates all the details of the impact of a car crash. It may take many pages to transcribe the events of less than 30 seconds.

The perception of space is relative to the impressions the author conveys, along with the worldly knowledge the reader brings to the text. If the reader has a strong perception of the time it takes to cover a certain distance by walking or driving, then the reader imposes that knowledge on his impression of the space covered in the story. Without such knowledge, the reader is more dependent on the author's choice of words and arrangement of elements to convey that sense of distance and space. A narrative can also convey the actions or events simultaneously happening in places that are miles or even worlds apart.

In the field of narratology, Bal defines a "description" as a piece of text used to describe the attributes of an object or place (36). These descriptions are meant to convey to the mind of the reader a setting, a situation, or a state of affairs. Understanding of a story often hinges on comprehending the situation in which the story takes place. A key premise of this dissertation is that a textual description can be transposed to a visual image without altering the integrity of the story, but that by being altered, it may improve a low-level reader's comprehension.

Reading from a Narratology Viewpoint

Gerald Prince, in the field of narratology, defines reading as, "an activity presupposing a text, a reader, and an interaction between the text and the reader such that the latter is able to

answer correctly at least some questions about the meaning of the former" (102). The reading process involves responding to cues, creating a framework, organizing the information, building up expectations, and the fulfilling or altering of those expectations (Rosenblatt 54). Comprehension errors or misreadings are likely the result of improperly processed cues or misleading expectations, rather than actual decoding errors (Rosenblatt 63).

Prince extensively outlined the cues related to the narrator, the narratee, cues of orientation, viewpoint, and metanarrative signs in his book on narratology. A "good" reader may not even be aware of how her mental framework is constructed by subtle uses of a second person pronoun or a first person plural that does not refer to a character (Prince 7). How the narrator addresses or refers to characters or the reader sets the tone of a story (Prince 35). A low-level reader, however, may have to work harder and more consciously to understand such things.

Prince notes that the focus of reading is moving from the author's intention to the reader's interpretation (102). Once a work is completed and leaves the control of the author, the reader is the magic potion that unlocks the secret of that work—the reader or audience is the key to unlocking meaning, relevance, or beauty (Rosenblatt ix; Jahn, Knauff, and Johnson-Laird 94). The coordination of social constructs, cultural orientation, and coding/decoding mechanisms are all vital to the reading process. Reading is not a passive state. It is a symphony of eye movements, of processing symbols, creating mental images, building cognitive frameworks of time and space, and populating that framework with places, characters, and events.

How We Read and Make Meaning

Decoding

We use a variety of signals to aid in decoding during the reading process. Beyond the phonemic ability to sound out the pronunciation of a word, those learning to read utilize pictures, contextual cues, and their knowledge of the world in order to make sense of what they read (Chiappe, Siegel, and Wade-Woolley 373; Connor, Morrison, and Petrella 683). Again, the act of reading comes back to the ability of the reader to make meaning of the text. Decoding the words, pronunciation, and grammatical accuracy are all structural issues. But without the ability to comprehend the story, these items merely form a shapeless outline. The ability to recognize connections and concepts can be similar to the transformation that occurs when you are looking into a dark room with unidentifiable shapes and shadows, and then a light is turned on, and suddenly those items are familiar and clear.

Carol McDonald Connor, Frederick Morrison, and Jocelyn Katch offer suggestions for instruction methods, noting that students with very low initial decoding skills benefitted most from teacher managed explicit instruction, while those with low initial vocabulary skills progress better with a program that began as teacher managed but progressed to child managed implicit instruction over the course of the school year (691). These findings, in a 2004 study of students in third grade, reinforce the notion that student experience and expertise level should dictate the method of instruction implemented. The research in this dissertation study implements the idea of "fading" so that the heaviest supplemental structure is at the beginning with the lowest comprehension level but "fades" as concepts are introduced and the reader becomes more familiar with the story setting, characters, and intent. In this study, the experimental version of

Chapter One explicitly presents all ten of the vocabulary words to be tested in the images, while Chapter Two only presents four of the ten vocabulary words explicitly, and instead the images focus on replacing descriptive text or cultural contextual imagery.

Making Meaning

There is a bidirectional and dialectical relationship between lived experience that is carried into any reading of literature and the experience gained from the reading of literature is carried over into a person's real-world experiences. Richard Bjornson states that "Any involvement with literature is necessarily embedded within the larger context of all human activity…" (51). The cognitive mapping model can be used as a way to view the function of literature as a mode of knowledge, much in the same way that we develop other sets of knowledge about the world around us. Just as we must have some foundational knowledge of the workings of the world in order to make sense of information we receive from our environment, we must have a basic understanding of society and how human interactions work in order to construct meaning from literature (Bjornson 52-54). Cognitive mapping provides an interpretive structure to which we attach meaning and that we use to organize and understand the things we perceive around us (Bjornson 54). This research concept provides images that replace descriptive text so that readers can utilize the imagery to quickly gain a sense of the environment or situation being discussed in the text. These images are not merely illustrations but replace bits of text and are meant to be "read" in line with the paragraph. Thus, the image lessens the load on the reader by removing some text to be decoded and processed and provides a visual context from which meaning can be made for the remaining text.

Orientation in Time and Space

The term "cognitive map" has gone through several alterations over the years. Initially, in 1948, the psychologist Edward Tolman originated this term to describe the navigational skills of rats in a maze and their ability to locate food. In 1960, Kevin Lynch adopted the term to denote mental images of complex spatial environments. Yi-Fu Tuan expanded Lynch's use of the term in 1975 to include the mental knowledge that enables people to draw freehand maps of areas. The term was given a valuative aspect by Peter Gould and Rodney White in 1974 with the connotation of spatial areas as dangerous, safe, or desirable. Finally, in 1981, Bjornson applied the term to the cognitive processing of literature. Bjornson specifically notes Tolman's three postulates regarding cognitive mapping: 1) all organisms pursue goals in any environment, 2) in order to attain these goals, functional representational constructs of the environment must be assembled from fragments of information, and 3) general working knowledge is a fluid combination of existing schemas and the integration of new information from the environment (52).

Simonides [of Ceos] suggested that the key to memory lies in the ability to form mental images such that the order of the image and location of items in the mental image will preserve the order of the memories (Ulmer 145). Readers build spatial and chronological maps of the literary world presented to them via text, but what they "know" about this constructed world and the objects in it is based on the overall image / vision created in their mind – rarely can they recall the exact words used to form this image (Bjornson 59; Bower and Morrow 44). As an example, if a class read a text about a turtle sitting on a log as a boat went by, the mental image is formed. Questions about the location of the turtle would be answered that the turtle is above

the water, on the log, without necessarily being able to recall the words that described the situation.

Georg Jahn, Markus Knauff, and P.N. Johnson-Laird conducted studies that verified that mental constructs are affected by cultural bias, specifically a predominance to spatially arrange items from left to right in the same manner subjects would read or write (2076). Personal experience, social schemas, and the text are combined into a creation of the reader's mind. The mental construction of the spatial arrangement of our knowledge of our world, our relative location within that world, and the use of schemas to fill in gaps and to make connections is a vital component in our ability to communicate with each other and navigate through our daily lives.

Bower and Morrow conducted a very interesting experiment in 1990 to test the spatial orientation of mental objects and to see if there was a lag in retrieval for objects perceived to be "farther away" from the main character. Undergraduate college students memorized the layout of two buildings, the rooms in the buildings, and items in those rooms. Eight stories were presented—four stories for each building. As the subjects read the story, they were periodically interrupted by questions offering two words. The subjects had to decide if these two objects were in the same room or different rooms. The response times were dependent on the location of the protagonist at that point in the story in relationship to his distance from the objects. Objects nearer the protagonist produced a faster response rate (Bower and Morrow 247). The authors also tested the relationship of response times for objects with regard to a major and a minor character. Objects near the major character generated faster response times than those near the minor character, regardless of the order in which the characters were mentioned (Bower and

Morrow 248). This suggests that, not only do we build spatial models of literary worlds, but that the physical laws of distance and time apply to some extent when we traverse those worlds.

This idea of building mental models of our world in order has been shown to be of cognitive importance since it gives memories a structure that can be navigated for recall and orientation. The mind stores information in a world-relevant format and the physical rules of that world apply to an extent to the location and retrieval of memories. The next section focuses on the impact that cognitive load can have on storing and understanding material. Factors of attention, comprehension, and orientation used in cognitive mapping can be affected by the format of materials presented, detractors present in the environment, and other items that compromise the formation of cognitive maps.

The Effect of Cognitive Load on Comprehension

Psychological studies of working memory, cognitive load, language, and reading are extremely important with the variety of multimedia available for students. In a 2001 study, Una Hutton and John Towse compared working memory and short-term memory as indicators of cognitive skills in eight year old and eleven year old children. Tasks associated with working memory were: reading comprehension, language comprehension, reasoning, mental arithmetic, and general intelligence (Hutton and Towse 384). Short-term memory was considered more passive, including recall of lists, and was reliant on rehearsal to maintain (Hutton and Towse 384-85). The authors concluded that working memory was more strongly linked to ability measures (Hutton and Towse 390). Because working memory is linked to long-term memory in order to facilitate processing, studies that directly measure cognitive load are important tools. Roland Brunken, Jan Plass and Detlev Leutner, as well as Krista DeLeeuw and Richard Mayer,

conducted studies that attempted to directly measure cognitive load during a multimedia presentation. The results and implications of these results are described below.

Cognitive Learning Theory

Cognitive Learning Theory (CLT) provides a theory-based approach to measuring the effectiveness of learning via multimedia and web-based instruction and now heavily influences the design of such instructional materials (Brunken, Plass, and Leutner 53). Cognitive load can be divided into three categories: intrinsic, extraneous, and germane. Intrinsic cognitive load is caused by the structure and complexity of the material. Extraneous cognitive load is imposed by the format and presentation of the material. Germane cognitive load is induced by the learner's efforts to process or comprehend the material (Brunken, Plass, and Leutner 54).

DeLeeuw and Mayer observed in their 2008 study that overall correlations were low between 1) self-reported mental effort ratings, 2) response time to a secondary task, and 3) reported ratings of difficulty (223). This means the perception of cognitive load is not indicative of immediate awareness of actual processing difficulty. This study showed that mental effort was sensitive to intrinsic processing (in this case, sentence complexity), while response time varied with extraneous processing (the redundancy in the text), and how the subjects rated the difficulty of the task was associated with germane processing (how well the subjects performed on the test for comprehension) (DeLeeuw and Mayer 223). For this experiment, the researchers implemented a computer program designed in Flash where the background occasionally slowly faded from pink to black and the subjects (college students between the ages of 17 and 22) were to press the spacebar as soon as they noticed the change. When they pressed the spacebar, they

were then prompted to rate their level of mental effort. Such episodes were strategically placed after both simple and complex sentences (DeLeeuw and Mayer 226-228).

Direct measurement of cognitive load can be difficult, but properly designed tasks can improve the reliability of these measures. Specifically, a dual-task measurement must be designed such that the secondary task requires using the same cognitive resources as the primary task. If such secondary tasks are well implemented, it becomes possible to: 1) measure cognitive load at the point at which it is induced and 2) identify the step in the processing at which the load is imposed. Also, having a "within subject" design makes the measurements independent of the individual research subject differences (Brunken, Plass, and Leutner 57). The correlation between various elements of cognitive load can be assessed per subject, and then correlated across a sample, rather than having to work with the average response rate of the all subjects in a sample. An example of such an experimental design was used in 2003 by Brunken, Plass, and Leutner, who had subjects reading text from a computer within an on-screen border or frame. In the border area was a letter in large font. The letter would slowly change from black to red, and subjects were instructed to press the spacebar as soon as they noticed the change (Brunken, Plass, and Leutner 58). The more difficult the passage was to read, the slower the reaction time to the color change due to the allocation of cognitive resources. However, the researchers noticed that, although the cognitive load increased from easy to moderately difficult tasks, there was a point where the tasks became too difficult and the research subjects mentally "checked out" and stopped trying (Brunken, Plass, and Leutner 58). The authors state, "…it is a learner's prior knowledge (i.e., the complexity of existing schemas for a particular subject matter) that determines what level of cognitive load the individual will experience" (Brunken, Plass, and Leutner 53). What a learner knows determines her ability to make meaning out of new material.

Existing schemas and the modification of those schemas are the most important factor in comprehension. This fact is a driving force in the development of the research concept for this dissertation.

Existing Knowledge as a Key to Learning New Content

Schemas

Kalyuga, Chandler, and Sweller assert that, "Schema is defined as a cognitive construct that permits people to treat multiple subelements of information as a single element, categorized according to the manner in which it will be used" (1). These authors studied first-year engineering apprentices and suggest that effective instructional design is heavily dependent on the level of expertise of the students. Schemas offer the ability of "chunking" information about the world into huge, interrelated categories with minimal cognitive load involved in retrieval and association. However, the schemas need to be sufficiently developed. Often, beginning learners require both the text and the image in order to make meaning out of the material. As their level of expertise improves, however, either the text or the image may become a distraction as they are able to pull sufficient information from only one source—such as an engineer who can read a schematic without the aid of explanatory text, or a student who can build images of environments in her head with only textual descriptions (Kalyuga, Chandler, and Sweller 6). The key is that those schemas have to be sufficiently mature in their development to be useful for comprehension (Kalyuga, Chandler, and Sweller 3).

The Role of Images

Results from programs designed to study the impact of using images with text, images alone, or text alone to convey a story or instructional information, show there is strong agreement that images aid in comprehension, particularly for readers who have minimal decoding problems but still exhibit comprehension issues (Levin 19; Pressley 610-612; Mayer and Sims 391). The advantage of images is reliant on specific situations and relative placement of the image and text. Richard Mayer and Valerie Sims note that the coordination of pictures and words was most beneficial for low-experienced learners (in their study, the subjects were college students) who do not have the background to pull relevant mental imagery from memory in the case of a text-only presentation or the ability to make sense of an image-alone presentation without the explanatory text present (391-392; Kalyuga, Chandler, and Sweller 3). Michael Pressley argues that readers with decoding issues, and younger students did not benefit significantly from illustration, while older children (in his 1977 study the older children were 8 years old) were able to make use of the visuals for their learning strategies—provided the illustrations were accurate depictions of the text (586, 613, 615). Joel Levin's 1971 study of fourth graders, demonstrated that "poor" decoders performed best in the "picture only" treatment, while the other two groups ("good" readers and "poor" comprehenders) each performed significantly better in the "reading with imagery" treatment (22). Levin's study included fifty-four fourth grade students, who were classified as "good" readers (at or above grade level), and "poor" readers. The "poor" reader group were further divided, such that one group was deemed to be lacking in decoding or vocabulary skills, and the other group had these skills, but lacked good reading habits (Levin 19, 21). This study used a twelve sentence story in a text only version, a picture only version (each picture represented a single sentence), and a

treatment that told the subjects to use mental imagery while the text was read (Levin 21). Because some of the students were reassessed into different classifications during the course of the study, the analysis was complicated (Levin 22). Those given instructions to visualize while reading performed the best, but Levin notes that this may not hold true for all types of readers (Levin 22, 23). He also suggests that the pictorial version only may need to be supplemented with text for those students lacking the fundamental skills (Levin 22, 23). Other studies reviewed in this chapter discuss such topics as meaning-making, knowledge of story construct, and other reading skills that likely undermined the students reading ability as well. Levin's study is part of the historical foundation of reading research, but did not have the advantage of grouping subjects according to the intensive evaluation of student skills, performance, and disabilities available today.

Younger children (as noted earlier in this section), may not have sufficiently developed skills for interpreting line drawing or images (Pressley 586, 613, 615), while Mayer and Sims noted that well coordinated text and visuals were most useful for low-experience learners (391-392). One factor in the interpretation of information is cognitive load. In dealing with cognitive load, it is important to be aware of placing an unnecessary burden on learners. Poorly designed illustrated texts can add to the comprehension issue by causing the learner extra work in coordinating information from the text with information from the images. When the problem is caused by placement of the information, this causes "split-attention" issues. When the images and the text overlap in their information, it is known as "redundancy." Slava Kalyuga, Paul Chandler, and John Sweller noted that "The distinction between split-attention and redundancy effects hinges on the distinction between sources of information that are intelligible in isolation and those that are not" (2). For their study, the group working with the diagram where the text

was integrated into the image significantly outperformed the other groups (Kalyuga, Chandler, and Sweller 4), as well as identified more faults in the schematic, which shows a higher transfer of knowledge (5).

The present research concept was designed with careful consideration given to the integration of images and text. In this modified version, the images are intended to replace text, which should lighten the learner's cognitive load. In addition, close attention was paid so that the images given to replace a bit of text did not contradict any other part of the text or the spirit of the story. Previous studies have shown that imagery is a useful tool for improving reading comprehension. One difference in this study is that the images are inserted into the text, to be "read" in the flow of the text, and are intended to provide a visual context for vocabulary and comprehension, while lessening the textual decoding load by replacing some sentences. The selection of the study subjects is based on scores either from a standardized test, or from individual assessments given upon matriculation. All of the subjects have scored well below grade-level, yet this is a distinctly non-homogenous group. The data analysis disaggregated by specific subgroup provides insight into which categories of students may best benefit from imagery with text.

Instructional Design and Comprehension

The goal of instructional design is the transfer of knowledge and the facilitation of comprehension. Specific methods of reducing extraneous and optimizing germane cognitive load include worked examples, goal-free activities, strategies of imagining, and activities based on design concepts of completion effect, redundancy effect, and modality effect (Brunken, Plass, and Leutner 54). Alan Manning and Nicole Amare state, "It is the assertion that both visual and

textual rhetoric belong to a common system, built on and guided by similar principles" (198). In their study of the ethics of visual rhetoric, they also point out that the "… ethical responsibility is in large part a responsibility not to waste (steal) the valuable time and intellectual resources of the audience…" (Manning and Amare 196). Richard Mayer and Roxana Moreno offer several ways of reducing cognitive load in multimedia learning. They state that "essential processing" is required to make sense of material, "incidental processing" is not required to make sense but is primed by the design of the learning task, and "representational holding" represents the cognitive processes that hold a mental representation in working memory (Mayer and Moreno 45). Mayer and Moreno also note that lessening the demands on any of these three systems will lessen the overall cognitive load (45). Integrating text and visuals (either by combining animation with narration rather than on-screen text or by placing text within the visual for better integration), segmenting the information by allowing space between the presentation of concepts to give students processing time, and using signaling within the presentation to cue students as to how to process the incoming material all significantly improve comprehension and retention by lessening cognitive load (Mayer and Moreno 46-49).

The Role of Presentation Medium

Laurene Krasney Meringoff studied the influence of medium on story comprehension in young children (half of whom averaged 7.6 years old and half of whom averaged 9.6 years old). Her research, done in 1978 in a public school in Massachusetts, showed that, when presented with a televised story, children remembered more story actions and offered shorter time and distance estimations, while those who had the story read to them remembered more vocabulary

and based their inferences on textual content combined with general knowledge and personal experience (240).

With the proliferation of multimedia learning software in education today such as Voyager Journeys, Read 180, and Inspiration, the interest in measuring the cognitive impact of electronic media versus paper has escalated. Financial statements of two of the top producers of educational software show that Renaissance Learning, Inc. increased their net sales from $116,283 in 2005 to $121,513 in 2009 (Renaissance Learning 21). Scholastic has grown from $1.78 Million in sales in 2005 to 1.85 Million in 2009 (Scholastic 17). Reading software and computerized versions of reading curriculum are big business. Matthew Kerr and Sonya Symons compared the time spent reading a passage and the comprehension of the material for fifth-grade students using a computerized presentation of text and traditional paper presentation. This study was conducted in 2006 with average to above average decoders, and the results may not hold for low performers (Kerr and Symons 15). They held the size and contrast constant with both presentations being the same font size and resolution. The paper presentation, however, held 31 lines per page compared to 28 lines per screen for the computer presentation (Kerr and Symons 7). Statistically, the children read faster in the paper presentation at 2.5 minutes per page versus 2.8 minutes per screen (Kerr and Symons 9). An interesting note, however, is that recall was better from reading on-screen, while comprehension was better in the paper format (Kerr and Symons 9). Since reading efficiency has been defined in the past as a measure of the reading rate and accuracy of comprehension (Carver 423; Kerr and Symons 9), the paper format dominated for efficiency. The authors note that reading speed and comprehension seem to be tied to the structural stability of the page-by-page presentation (Kerr and Symons 5). Kerr and Symons suggest that “good” comprehenders are often superior at remembering relative positions of

specific words in a text (14). This would correspond with spatial memory and mental mapping orientation and follow Simonides' [of Ceos] suggestion of creating a mental image of the location of information. Higher-level readers often remember the relative location of a passage in an article, such as "on the right-side page, in the upper section of the second column, above a bold heading…" in order to re-locate an item of interest. Good comprehenders map their way through the text, as well as create mental images of the action or dialogue being presented by the text. This issue was accounted for in the design of the research instrument by eliminating "scrolling" and using the "page-up" and "page-down" buttons. This also kept the integrity of the construct of the relative position of text and images on the page intact.

Comprehension, as noted above, is influenced by physical structure of the text, but is also dependent on how the mind processes information. The strategies used by strong readers allow them to create mental representations of information. The following section describes research which studied the question of how embedded verbal and visual strategies affect comprehension.

The Role of Instructional and Comprehension Strategies

A study conducted over a ten week period by Mina Johnson-Glenberg in 2000, worked with third through fifth grade students who were "poor" comprehenders. She wanted to answer the question, "do embedded verbal and/or visual strategies improve comprehension, and do they affect elective re-reading of the text?" (Johnson-Glenberg 755). The embedded strategies prompted subjects to create "a question a teacher would ask" based on a particular passage or to build a visual representation based on the text (Johnson-Glenberg 757). Johnson-Glenberg states, "The ultimate act of reading is the creation of a mental model…creating a visual model on the screen concretely aids "poor" readers in building internal visual models" (760). The results of the

Johnson-Glenberg study demonstrated that both experimental groups (one group using visual strategies, another group using verbal strategies) showed significant comprehension gains over the control group who were simply told to read the passage (757). Johnson-Glenberg concluded that the use of higher-level verbal strategies in conjunction with visual processing appear to increase deeper levels of comprehension for readers (775). Note that in this study, the students were reading a text only passage. The focus was to teach students to read with awareness and to utilize mental visualization and other skills that would aid in building a mental model of the story. Although this work references Levin's methodology for his study, this research did not use pictorial versions or illustrated versions of stories, but rather compared reading strategies for improving comprehension.

Construction of This Research Study

Key considerations in this study are focused on creating a testing instrument that does not interfere with the natural structure of reading, yet brings a stronger, visual context to the reader to use for improving understanding of the story. As Bower and Morrow noted, a story or narrative is composed of characters, their relationships, traits, and the mental map of the physical location in which the action takes place (44). The story being told by a narrative consists of the combination of characters, their actions, and the results or effects of those actions (Bal 5, Bower and Morrow 44, Johnson-Glenberg 760, Pinker 66). The appropriate replacement of text with informationally equivalent images does not alter the story, the characters, or their actions. A significant difference in this research and previous research is a reliance on the theories of decoding and symbol sets (Miller 93-94; Salomon xix, 13, 19, 70). This facilitates the acceptance of the assumption that a story written for the appropriate age and reading level can be "coded" by

replacing descriptive text with images such that students can "decode" without compromising the story (the narrative of the characters and actions in the book used for the study). Salomon noted that providing a learner with visual supplements improves learning by improving comprehension and reducing cognitive load (66, 70, 72). The research in this dissertation captures data from a seemingly homogenous group of students, based on reading scores, and disaggregates the performance of those students based on demographic factors comparing their performance using a text only reading model and a text with integrated images reading model. In the analysis, the experimental model is statistically similar to the text only model for a large percentage of students. However, insight comes in disaggregating the results by specific subgroups and noting where the text only version fails, while the text with images shows learning gains.

Strategic Replacement of Text with Images

Unlike many of the web-based learning tools, there will be no words or sections of text in the story which can be clicked to open a page of definitions or to show an image for further explanation. This is not a non-linear- or hypertext-based tool. Other than the presentation via computer, the reading will be formatted very much as it would on paper. Images and illustrations will be included strictly as a replacement for descriptive text, not as an additional burden on the reader but as a tool to lessen cognitive load. It has been shown that decoding skill is improved with the use of pictures and contextual cues (Chiappe, Siegel, and Wade-Woolley 373). Particularly for students who are behind their peers and struggling to close the achievement gap, rapid improvement of vocabulary skills and reading comprehension is vital. The purpose of the experimental format is to provide visual images that cue contextual meaning, which can be the

difference between making a series of phonemic symbols and reading words that form coherent meaning.

Decoding is not equivalent to making meaning (Connor, Morrison, and Petrella 683). Connor, Morrison, and Petrella also, along with Bjornson, noted that there exists a bidirectional relationship between literature and lived experience (Connor, Morrison, and Petrella 683; Bjornson 51). Being able to combine a series of words and images into coherent meaning and weave that meaning into an existing schema of how some portion of the world functions is necessary for low-level comprehenders to move into the realm of high-level readers. Often, lack of experience (either personal, direct experience, or experience via movies, literature, or other indirect means) limits comprehension. For a child from the arid portion of Nevada, the idea of Venice, the city built on the water, would very likely not fit into any of his existing schemas. Even the order of things, driving on the right side of the road, or how buildings look can cause comprehension issues. Jahn, Knauff, and Johnson-Laird noted that mental constructs are affected by cultural bias—even something as simple as a cultural norm that reads or processes information from left to right. People from this type of culture consistently show a preference for linking object from left to right when told they are "adjacent" to each other (Jahn, Knauff, and Johnson-Laird 2076). By replacing descriptive text with images, a stronger, more cohesive mental construct of the story world can be created with less cognitive struggle.

Considerations of Cognitive Load in Instrument Design

Although this study was not designed to implicitly measure cognitive load, applying Cognitive Load Theory to the design of the instrument is important. The complexity of the material determines the intrinsic load, so appropriate reading material must be chosen. Extrinsic

load is affected by the method of presenting the material and the format of the information. In the study by Kerr and Symons, the physical and spatial construct of the text had a noticeable effect (5), which means that attention should be paid to the physical compilation of the reading material to minimize the extrinsic load. The overarching intent is to improve comprehension of struggling readers. Lowering the effort required by learners to process and comprehend material will lighten the germane load. Attention to these three categories should lessen the cognitive load overall and theoretically improve learning (Brunken, Plass, and Leutner 53-54).

Further potential to lessen the cognitive load comes from the research of Mayer and Moreno who suggest that there are three key processing issues. The essential processing is needed to make sense of something. The incidental processing is primed by the task design, cues as to what will be expected, and how to manage a task. Representational holding is the effort to maintain a mental representation in memory. This concept of replacing some descriptive text with images, while maintaining the actions and character descriptions as text, should directly help with representational holding. Incidental processing can be simplified with an awareness of the construct of images and text in the physical spatial layout, as well as with basic instructions that the images are to be "read" in-line with the text. With these two components accounted for, the essential processing task should have access to a larger portion of available cognitive processing ability.

Considerations of Existing Knowledge Base of Students

The experience level of the learner is the fulcrum on which all the instructional design balances. Kalyuga, Chandler, and Sweller pressed the point of the importance of the experience level of the learner (3, 6). If the learner is not presented with sufficiently novel information, the

scale tips too far and is not balanced for growth. If the information is too novel, then there are no existing schemas where the new bits can be connected, the scale tips too far in the other direction and again, little learning occurs. For this study, the images replacing portions of the text will act as ready-made schemas for learners. It has been noted by Bal, Salomon, and Barthes that there is not a one-to-one relationship between any given signifier and any given signified. Any single word is not limited to invoking only one specific image, and any single image is not limited to invoking the label of a single word. Even a proper name of a person might invoke a large variety of images or perceptions of that person or their accomplishments, depending on who is processing the thoughts. Synonyms, multiple languages, and range of lived experiences preclude a one-to-one relationship of sign and signifier. For readers who are behind, the lack of vocabulary can be a pitfall. Most students in this category would not know the word oxcart. However, if you show them an image of a cart being pulled by an ox, they can describe it, usually as a wagon pulled by a cow. The description is not altogether accurate or inaccurate, but by making the link to that existing schema and supplying the new vocabulary in the action text, meaning can be made and the schema can be modified.

This study blends methods and ideas from a variety of previous research. Combining images with text has been shown to improve comprehension for readers (Levin 19,22; Pressley 610-12; Mayer and Sims 391-92; Kalyuga, Chandler, and Sweller 3, 4; Stothard and Hulme 98; Cain 178). The spatial construct of reading has been shown to impact comprehension and memory (Kerr and Symons 5, 14). It has been noted that the cognitive process of reading may begin and end with words, either verbal or text, but that the mediating process of comprehension and understanding is not necessarily verbal (Pavio 241-42, 254, 257; Vygotsky 80; Hancock 137; Marzano 575), and models of that process have been presented by Baddeley (190-96), Schnotz

and Bannert (142-43), and Mayer (37). The efficacy of that mediating process in producing coherent meaning has been shown to be reliant on existing cognitive maps and prior knowledge (Brunken, Plass, and Leutner 53; Mayer 24, 25). This study combines all of these concepts in the experimental version of the reading selection used. The original text is one that is intended to be used by low level readers, in that the vocabulary and sentence structure is not overly complex. The images created to be integrated into the text were designed to be accurate depictions of the text being replaced, which Pressley noted was of importance (586, 613, 615). The text and images are integrated to aid with making visual connection, and lessen the cognitive load of assimilation (Kalyuga, Chandler, and Sweller 4). Also, the images actually replace some sentences, instead of being an additional burden for the reader, which is intended to lessen the cognitive load, thereby improving comprehension (Brunken, Plass, and Leutner 53, 57, 58; DeLeeuw and Mayer 223). Finally, the selection of students is based on their grouping by reading scores, giving a broad range of demographics, disabilities, and language skills by which the data can be disaggregated and analyzed.

The ultimate goal is to find methods that improve students' ability to read and comprehend information. By combining research from these different disciplines, more can be learned about the best methods for supplementing and enhancing text such that low-level comprehenders are better able to make meaning and construct mental images. All of the above considerations were taken into account in the design and implementation of this study. The following chapter discusses the design of the experiment, the instrument used, and information on the study subjects.

CHAPTER 3 – RESEARCH INSTRUMENT AND METHOD

This chapter will explain the design of the research study format, the selection and organization of the study materials, and demographic information of the subjects. The purpose of this experiment was to evaluate the effectiveness of an alternate reading format with regard to vocabulary and comprehension acquisition. It was hypothesized that replacing portions of text with informationally equivalent images would lessen the cognitive load of the readers, enabling them to situate the content of the story into their existing schemas, while also allowing more resources to be used for the reading of novel material.

Experimental Design

This study was designed with the cooperation of the reading teachers at the participating middle school. Students who participated in this study ranged from sixth to eighth grades, with ages ranging from 11 years, 1 month, to 16 years, 3 months. The selection of students was based on their reading score, which determined their placement in special reading classes at the school. These were students who were above the instructional level of decoding and phonics, but read at the lowest reading level for standardized testing. Although this seemed to be a homogeneous selection of students, with similar test scores and reading performance levels, the demographics of the group told another story. Breaking down the students' performance by gender, language

status, and educational disability allowed a much deeper analysis of performance. There were approximately twenty percent more males than females in the study, which is higher than the State and National averages of ten percent and eight percent respectively (Nation's Report Card 66). Approximately a third of the students in the study had a documented learning disability, and the students who were English language learners made up almost half of the group.

Once the reading material was chosen, the researcher and participating teachers, along with the school's reading coach, discussed the ability and endurance of the students. It was important to assess the proper length of reading to have them complete. As has been noted by Brunken, Plass, and Leutner, there is a point at which students can become overwhelmed and simply stop trying (58). This factor was considered when structuring the research plan. In order to minimize the disruption to the students' core curriculum, it was agreed that the study would be constructed to take up two class periods for each of the participating classes. It was agreed that the students would likely be able to complete one chapter per day, along with the pre- and post-tests. This would be more material than they normally would read in a regular class period, but the time would be sufficient because there would be no discussion or background lecture involved.

In addition, the students who were English language learners were given the instructions in English and Spanish. These students were also allowed to answer in Spanish. They were told that the goal was to show their understanding and that if they lacked the English vocabulary to describe or answer fully, they could write their answers in Spanish.

Materials

In constructing this study, it was important to find a piece of literature that was designed for this particular age group and reading level that had not been read by any of the participants. It was fortunate that such a work was available at the school site, in sufficient quantities to conduct this study with full classes of students. The reading material chosen for this study is a book designed for low-level readers called *The Clay Marble: with Connections* by Minfong Ho, published by Holt, Rinehart, and Winston in 1991. The full story is 18 chapters, 163 pages, and includes supplemental reading selections for teachers to integrate into their lesson plans. This book has not been used by the teachers at the school where this study was conducted due to the students' lack of familiarity with the cultural content, which adds to the already difficult task of comprehension. The words are generally simple words and pose few, if any, decoding problems. However, the unfamiliar setting and different terminology in the vocabulary make this novel a good choice for this study.

The story is written from the viewpoint of a young, adolescent girl in a Cambodian family during the Vietnam War era. Her family lives in a rural village. Most of the villagers raise rice and vegetables and live a very simple life. The proximity of the Vietnam War fighting, which overflowed across national borders into Cambodia, turns her life upside down. Soldiers occupy her village. Her brother is forced into a work camp. Her father is killed. Eventually, due to opposing soldiers taking over the area, her brother escapes back home to find the village and crops burned or destroyed. The girl, her mother, and her brother set off in hopes of finding a place at the Thai border where they can find supplies and food to rebuild their lives. The portion of the story used for this study tells of their journey through the rain forest and their arrival at the refugee camp, Nong Chan.

Many of the concepts in the story are familiar to the students, such as war, agriculturally based living, and the loss of loved ones. However, the cultural differences such as rice paddies instead of fields, the use of oxcarts and oxen for transportation, and Buddhist traditions made the book difficult for teachers to use without extensive background preparation. This is the main reason that the students had not already read the book in their curriculum. It is also why it was an appealing choice to test vocabulary growth and comprehension.

Reading Selection

The reading selection consists of the first two chapters of the novel. Chapter One of the book is formatted as 9 pages long (8.5 full pages of text), while Chapter Two is formatted as 11 pages long (10 full pages of text). In the experimental version, Chapter One has 18 slides, while Chapter Two is comprised of 21 slides. This limitation was chosen to minimize time away from core curriculum for these students and as a concession to the time required to run this study with as many students as possible. Each group of participants were given two class periods to complete the reading. Each class period is approximately 46 minutes. Considering the level of the text and the amount of reading, each student was expected to be able to complete a single chapter, along with pre- and post-tests, in a single class period. Students who have a "double block" of reading where they remain in their assigned reading class for two class periods still used the schedule that follows in order to get a more standard data set and to reduce the effect of fatigue on the test results. Rereading of a previous page was permitted in both the paper version and computer version of the text.

Text Formats

The Control Version

The control group, identified as Group A, remained in their classroom with the classroom teachers. These students read the story from the book, a hard cover book of paperback dimensions, with 12 point, black font on white (albeit aged) pages. The pages were 8.25” high by 5.25” wide, with 0.75” top and bottom margins and a 1” margin on the outer edge, while the inner edge margin was smaller, dictated by the binding of the book. Chapter One is eight and a half pages long. Chapter Two is ten pages long. Figure 8 below is page 9 of the text version. This is the actual page layout and actual size.

at him now. What if he was wrong, and there was no such thing? The thick forest stretched out in front of us quiet and dark. There seemed to be no end to it.

Then I heard it again, the distinct sound of a clear bronze bell in the distance. It was coming closer. I sat up straight and noticed that Sarun had cocked his head toward the sound. So he had heard something, too.

Then I saw it.

Smooth and polished, the bronze bell flashed in the afternoon sun. It was dangling from the neck of a milk-white Brahman bull, who slowly emerged from the shadows of some teak trees.

"I told you!" I said triumphantly.

Sarun just stared, awestruck.

The bull was pulling a cart heaped high with gunnysacks of rice, with plowshares, with hoe heads, with rope and even fishnets. So heavily laden was the cart that it swayed from side to side as it moved, creaking noisily.

As we watched, the wheels of the oxcart slipped into a deep rut and lodged there. The driver stood up in the cart and flicked his whip at the ox, urging it to pull. Nostrils flared, the bull strained at its harness. But it was no use. The cart did not budge.

Sarun jumped down from our oxcart and ran over to the other wagon. Nodding briefly at the driver, he gripped one of the spokes in the stuck wheel and began to push. The other man climbed down and joined him. For some time there was only the sound of grunts as both men applied their weight on either side of the large wooden wheel. Then slowly, inch by inch, they eased it out of the rut, and the cartwheel rolled free.

Figure 8. This is page 9 of *The Clay Marble* text used in the control group.

The Experimental Version

The experimental group used desktop computers in the computer reading lab setting (they attend classes in this computer lab on a regular rotation). The experimental version of the novel was created using Microsoft PowerPoint. Students viewed the modified text in a Microsoft PowerPoint slideshow format. Screen resolution was set at 1024 x 768 pixels. The font in the PowerPoint slides was 18 point, Arial. Text was black on a white background. A full copy of the computerized version, including notation of the sentences which were replaced by images, can be found in Appendix G. Below is a sample slide, containing part of the text from page 9 of the text version, shown previously in Figure 8.

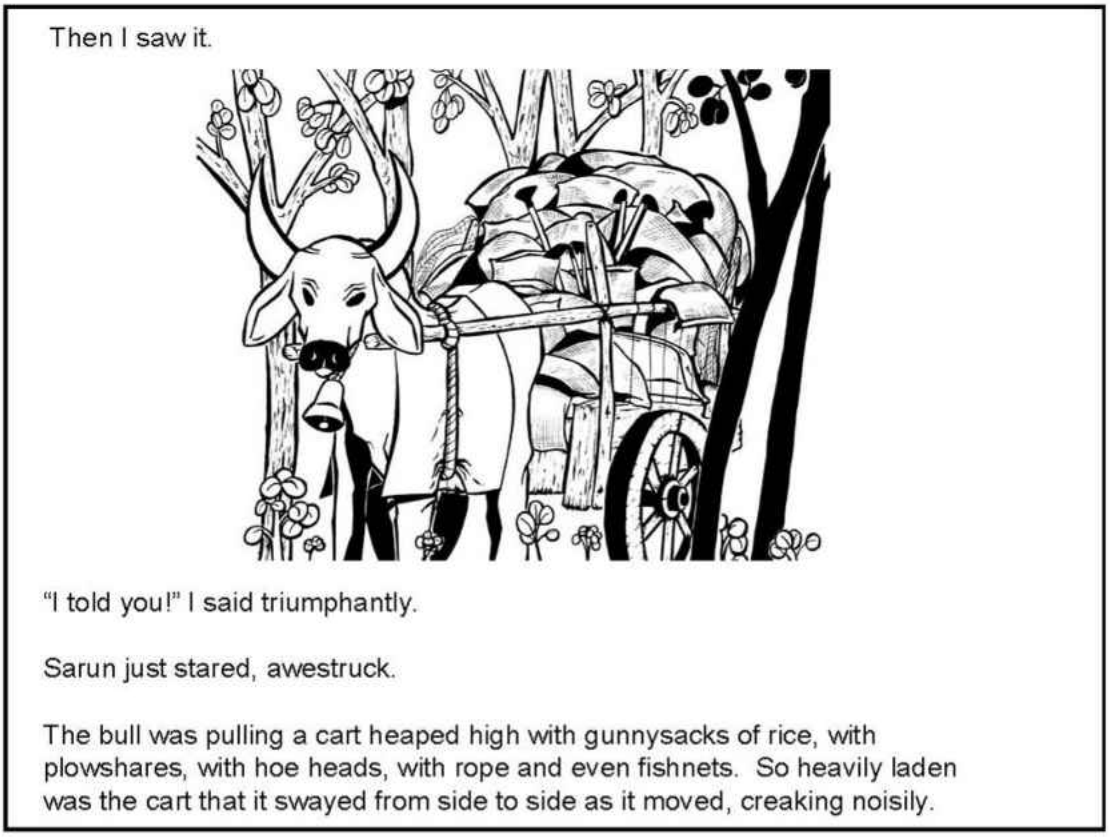


Figure 9. Slide 14 from Chapter One (corresponds to part of the text on page 9 of the book, shown in Figure 8).

Images used to replace portions of the descriptive text are also black and white. These images were created by a graphic artist specifically for this purpose and are not stock images. It is broadly recognized that images aid in comprehension (Levin 19, 22; Pressley 610-612; Mayer and Sims 391-92; Kalyuga, Chandler, and Sweller 3) and that illustrations that are accurate depictions of the text are of much greater value for comprehension (Pressley 586, 613, 615). Attention was paid to the issue of redundancy and split-attention such that the images are intended to replace specific text and are, therefore, not redundant to the story. In addition, the images are designed to be "read" in line with the text, which avoids the issue of having students look to an opposite page to review a supplemental illustration and then having to find their place in the text again or reconcile the illustration with the text.

Attention was given to the spatial allocation for the text. No scrolling is required. Kerr and Symons noted in their study that the spatial layout of the text seemed to play a role in comprehension and recall of information (5). Students were instructed to use the "page-down" and "page-up" buttons on the keyboard in order to move forward or back in the story. The slides were intended to replicate the static layout of a page of text, due to prior studies that showed that the spatial layout of text on a page played a role in recollection of information, possibly due to assigning a spatial location to particular pieces of information (Kerr and Symons 5, 14).

In Chapter One, eight images were inserted to replace ten sentences. In Chapter Two, eight images were inserted to replace fifteen sentences. In Chapter One, ten of the ten vocabulary words being tested are shown in at least one image, but all are given as words in the text. Of the vocabulary tested for Chapter Two, only four words are given in images, but all the words are used in the text. Images that were used but that did not explicitly display a vocabulary word were intended to relate physical information regarding the setting or action of the story. This

integration of the text and diagram are important as it leads to significant improvement in performance (Kalyuga, Chandler, and Sweller 4).

The choice of which images to use and which text to replace was made based on conversations with the reading teachers and the reading coach at the school, along with a sense of the knowledge and needs of the students. I have eleven years of experience as an instructional faculty member and technology coordinator working with teachers, coordinating and facilitating student testing, and working with students from all grade levels in this particular middle school. This experience provides an awareness of the students' ability levels and an understanding of the students.

Bower and Morrow have suggested that the purpose of a narrative is so that the reader may create a mental world of places, events, and people from the communication of the text (44). Johnson-Glenberg agrees that reading is intended to create a mental model of a world and the events of that world (760). The images in this study were intended to visually supplement the students' reading in order give an additional source for meaning making. For Chapter One, the eight images replace 10 sentences. In Chapter Two, eight images are inserted, replacing 15 sentences. It was hypothesized that using the images and lessening the textual load would improve the readers' ability to situate the content of the story into their existing schemas, while also lessening the cognitive load and allowing more resources to be used for the reading of novel material (Brunken, Plass, and Leutner 53). The images were specifically designed to be accurate depictions of the narrative being replaced as recommended by Pressley (610-12). However, as has been noted previously, this study uses the theories composed by Salomon (33, 66, 70) and Pavio (241-42, 254, 257) with regard to the idea that there is no one-to-one relationship between any given word, or any given image, and the meaning or mental constructs associated. Thus, the

images which were exchanged for the sentences may lose the ability to confer conditional states (Salomon 66), but the overall comprehension may be improved (Salomon 72).

Figure 10 below shows the first screen from the computer version for the experimental group. The image is designed to replace the following text, "Dappled shadows stirred under a thick canopy of wild tamarind and rain trees, but there was no sign of life on the narrow trail stretching out ahead of us." This image helps orient the student's schema for the setting of the story in an unfamiliar landscape. It also eliminates some difficult text and lightens the cognitive load of the readers.

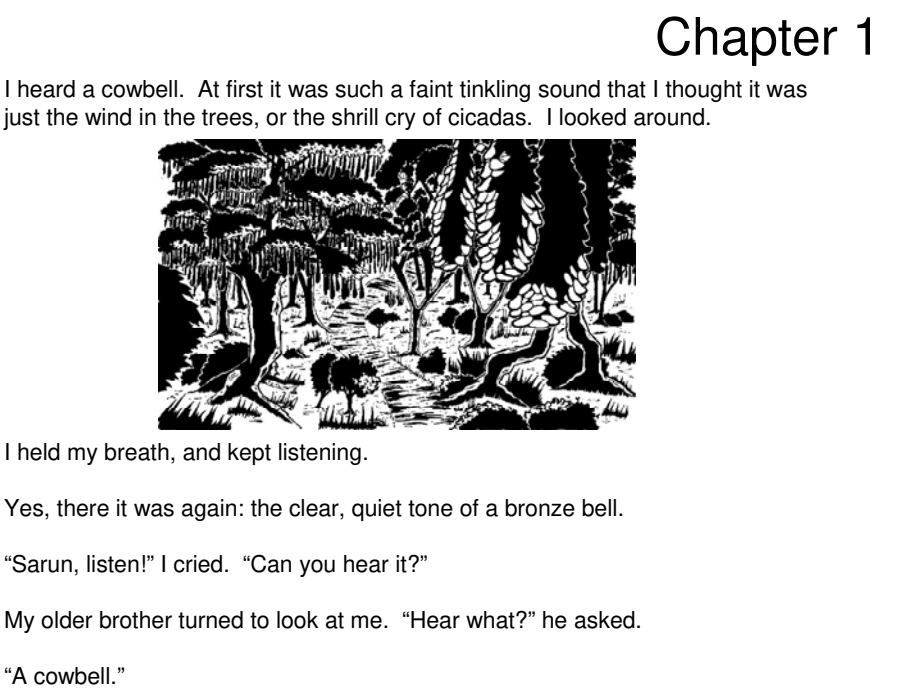


Figure 10. Sample of the computer version of the reading material. The image shown replaces the text "Dappled shadows stirred under a thick canopy of wild tamarind and rain trees, but there was no sign of life on the narrow trail stretching out ahead of us."

The text that was replaced was selected based on a combination of factors. The first consideration was the ability of an image to convey the same information in order to supplement student schemas and facilitate meaning making. Conditional states are not equivocally

transmitted via imagery (Salomon ##). Care was taken to ensure that the images were appropriate, sufficient, and that they communicated the same information as the text being replaced. Additionally, by replacing this difficult section of text with an image, the cognitive load is lessened. The image portrays a forest setting, the word "trees" is on this slide and the word "forest" is on the following slide. Key items such as the image of an oxcart, a Brahman bull, the gunnysacks of rice, and the images of the refugee camp and forest were all important in order for the students to have better personalization and contact with the story. Figure 11 below is a sample slide from Chapter Two.

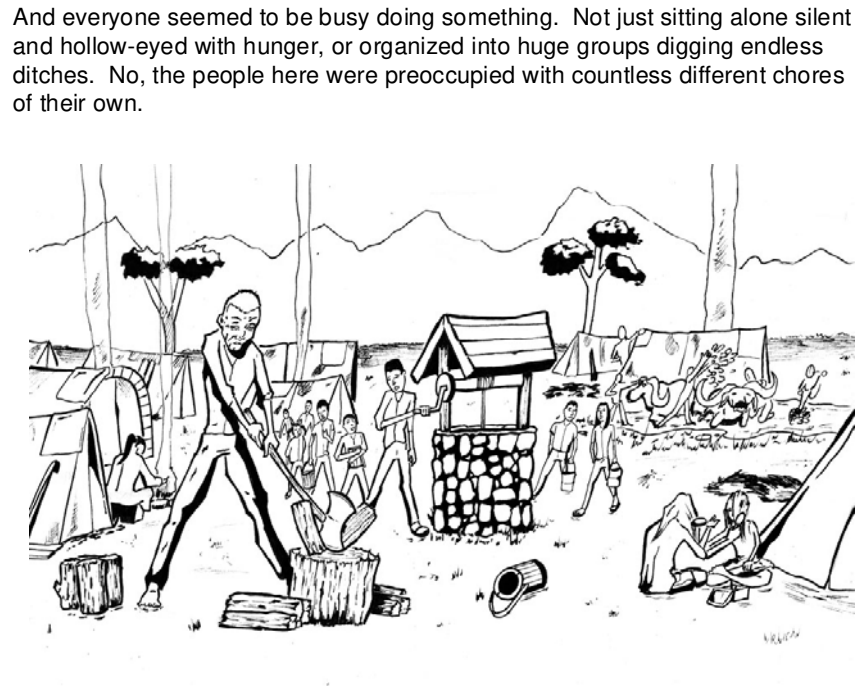


Figure 11. The text replaced by the image is, "I saw a sinewy old man splitting firewood; children lining up to draw buckets of water from a well; boys scrubbing their buffaloes in a shallow mudhole nearby; sisters combing each other's hair."

These images also help with unfamiliar terms or situations. The level of difficulty of a passage was used to select key items to be transformed into images. The appropriateness and difficulty level were determined based on eleven years of experience working with students and

teachers at this particular school. The images are intended to be of items in the passage that are most likely to assist readers in comprehension and vocabulary context support, based on teaching experience and a knowledge of the research background.

Measurement Tools

A pre-test of ten vocabulary words was given to each student, prior to reading each chapter. After reading the chapter, students were given a post-test of the same vocabulary words, arranged in a different order. These instruments are included in the appendix. The pre- and post-tests for each chapter consisted of ten words, such that twenty vocabulary words were tested in total. After reading Chapter Two, in addition to the vocabulary post-test, a five question comprehension test was given, a copy of which is also included in the appendix. Details on the scoring of these instruments is given later in this chapter in the Scoring Method section.

Study Subjects

The organization of this study used intensive reading classes, designed to remediate and aid students with very low reading scores. For the Florida Comprehensive Achievement Test (FCAT), the scores range from a Level 1 on the low end to a Level 5 on the high end, with Level 3 considered to be on grade level. These reading classes work with students who have scored a Level 1 or low Level 2 on the reading portion of the FCAT, or students who have matriculated without FCAT scores and have been individually tested for reading ability. For this study, classes with the lowest performing students who are working on decoding skills (classes that focus on phonics and pronunciation of letter combinations) were eliminated from the selection. The

participating group consisted of twenty classes, taught by six different teachers. This study was conducted with students in sixth through eighth grades at a typical public middle school in Orlando, Florida.

Table 1. This table shows the schedule used with the participating classes in this study. Classes are denoted by teacher initials and grade level.

	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**
Day 1	AZ8	SK8	AZ7		AZ6	SK6
Day 2	AZ8	SK8	AZ7		AZ6	SK6
Day 3			TT6	TJ8	TJ8	
Day 4			TT6	TJ8	TJ8	
Day 5	KL7		BM7		KL6	BM6
Day 6	KL7		BM7		KL6	BM6

This selection of classes provided a pool of 133 students. Of these, 48 were in sixth grade (13 females, 35 males), 37 were in seventh grade (16 females, 21 males), and 48 were in eighth grade (19 females, 29 males). In coordination with the teachers of these classes, it was decided that the study would be conducted such that it would take up only two periods of instruction (one period on each of two consecutive days) for each class. The schedule is shown above, where classes are denoted with teachers' initials and the number representing the grade level of that class.

The students were divided into a control group (Group A) and an experimental group (Group C). This division allowed the students to focus only on the method being used for their particular group, and provided a means of contrasting the standard method of reading (from the book in the text format) with the experimental method (slides with text and images). In the

division of the students into study groups, the final breakdown was such that Group A had 63 students, and Group C had 61. An overview of the student demographics are shown in the table below. At the time of the study, subject age ranges were as follows: sixth graders ranged from 11 years, 1 month to 13 years, 11 months; seventh graders ranged from 11 years, 8 months to 15 years, 6 months; and eighth graders ranged from 13 years, 1 month to 16 years, 3 months.

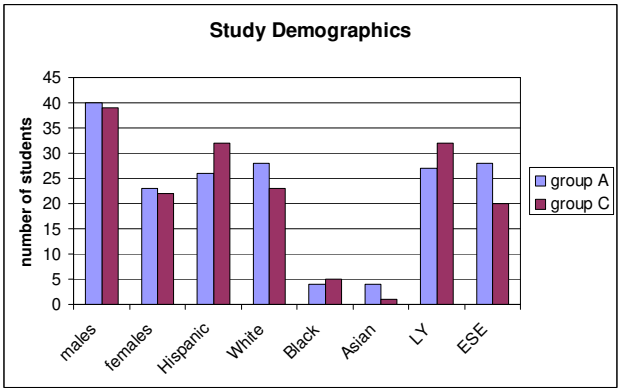


Figure 12. A visual representation of the demographic distribution of the study subjects in the control group (Group A) compared to the experimental group (Group C).

Detailed demographic information on the participating students included their date of birth, ethnicity, status as English Language Learners, status for any educational exceptionalities that warrant modifications or special services, and the categorical breakdown of their most recent FCAT reading exam. Relevant demographic information is included in this dissertation, but only as an aspect of statistical relevance, in the form of anonymous data analysis by group. Below, the distribution of the participating students is shown by categories of statistical interest.

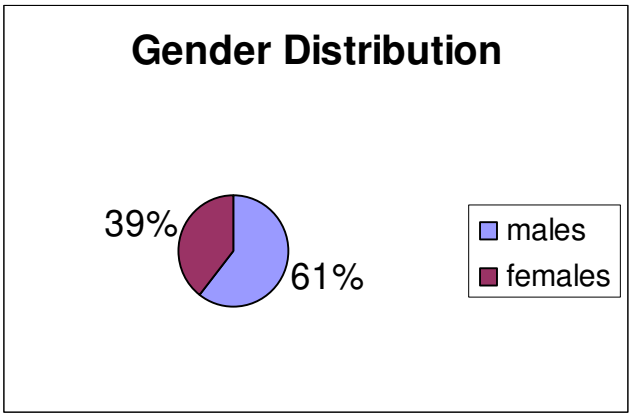


Figure 13. The distribution of gender among the participating students for this study.

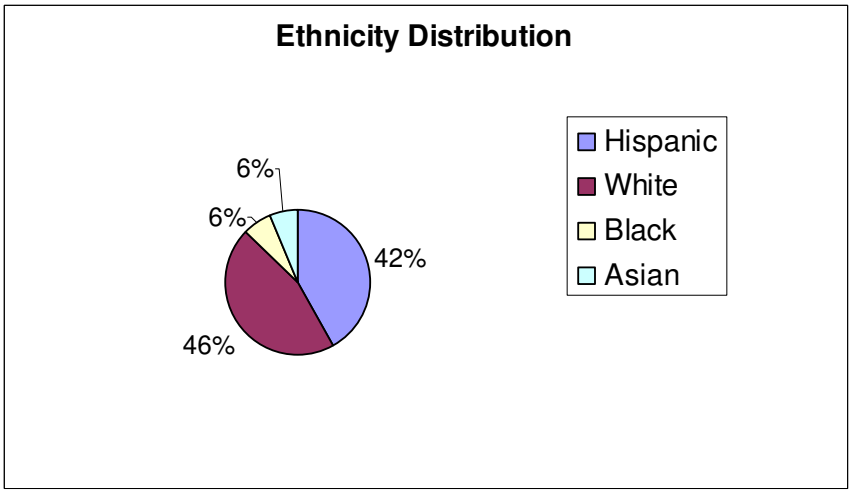


Figure 14. The distribution of ethnicities among the participating students for this study.

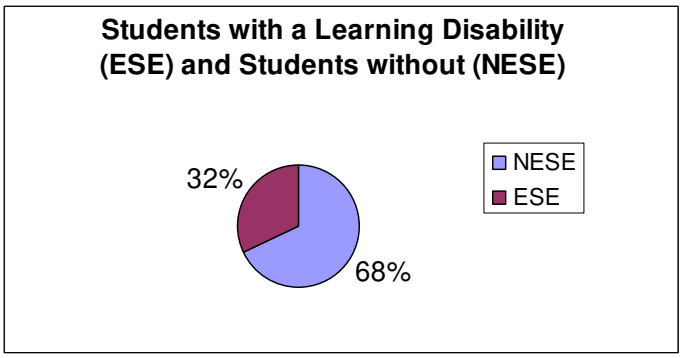


Figure 15. The distribution of students with learning disabilities and students without learning disabilities among the participating students for this study.

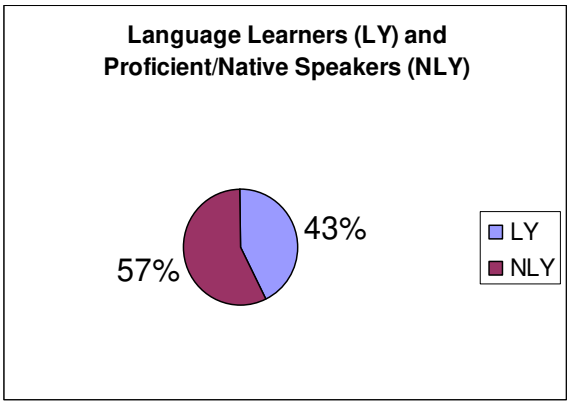


Figure 16. The distribution of language learners and proficient/native English speakers among the participating students for this study.

Categorically, these groups can be further refined to examine the percentage of students who are language learners and have learning disabilities (LYwESE), students who are language learners and do not have learning disabilities (LYwNESE), students who are proficient/native speakers and have learning disabilities (NLYwESE), and students who are proficient/native speakers and do not have learning disabilities (NLYwNESE). These groups are shown in the chart below.

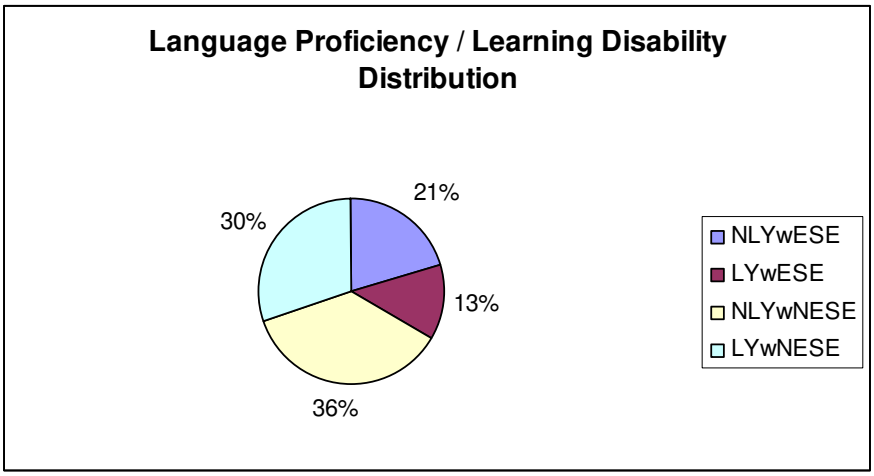


Figure 17. Percentage distribution of possible combinations of Language Learners (LY), Proficient/Native Speakers (NLY), students with Learning Disabilities (ESE), and students without Learning Disabilities (NESE).

Method

Day One, each group was given a ten-question pre-test of vocabulary words and then asked to read Chapter One. A post-test of the same ten vocabulary words, in a different order, was given after the reading is complete. On Day Two, each group was given a pretest of ten vocabulary words pertaining to Chapter Two, and then asked to read that chapter. After completing the reading of Chapter Two, each group was given a post test of the chapter two vocabulary words, as well as a five-question comprehension test covering the events of the first two chapters. The vocabulary words for Chapter One were: cowbell, oxen, forest, cart/oxcart, the Border, cartwheel, rice seed, temple, village, and gunnysack. The vocabulary words for Chapter Two consisted of: converging, twig, kindling, refugee camp, well/well water, beam/crossbeam, sarong, dipper/ladle, mat/sleeping mat, and barren. A full version of the research instrument, along with vocabulary tests and comprehension tests, are included as appendices. The students were allowed to answer by describing or explaining each vocabulary word. It was emphasized that a dictionary definition was not needed, but that it was important to show that they knew what the word meant or what it was.

The participating classroom teachers told the students, a few days ahead of the study, that they would be part of a special project. For each class, on the first day of the study, I introduced myself to the students and explained the study. Students were told that the main reason for the study was to test the format of the reading, and that it was important for them to try their best in order to determine which method worked better. Emphasis was given to the point that this was not just another reading test and that it did not reflect upon the students' reading ability. Students

were told that the point of the study was to help test which method might make the biggest improvement for them in reading and that it was important for both groups to try their best.

Students were not allowed to look up words in a dictionary (a common practice in a reading class), but encouraged to answer what they could, and reassured that not knowing all the words at the beginning was an important part of the study. Keeping up the morale of these students was important, as they are prone to give up when they feel they are not being successful. Mental and emotional fatigue, although not explicitly measured in this study, is a daily struggle for these students. The teachers and I did much to encourage them throughout their two days of the study.

After the introduction, students were given the Chapter One pre-test and asked to do their best to explain the words. It was emphasized that what was important was that they write down their idea of what the word meant or what it related to. After the administration of the Chapter One pre-test, students were separated into their respective groups. In the first two days of the study, folded strips of paper were placed in a small bag, and each student drew one piece of paper from the bag. The group was divided in half by the students who drew a letter and the students who drew a number. If there was an odd number of students, the extra student was assigned to the experimental group. After the first two days, it was decided that this step wasted the already limited time, and for the remaining classes, I printed a class roster and drew the letters and numbers to assign the students, prior to starting their portion of the study.

The control group was given books and instructed as to which pages to read and told that the other group would be reading the same material but in another format in another location. The experimental group left the classroom with me to move to the computer lab for further

instruction. The classroom teacher remained with the control group to monitor their reading and administer the Chapter One post-test.

The experimental group was moved quickly to the computer lab, which is a room these reading students use on a regular basis. Each student was assigned to a computer, and instructions were given that they should read the text, and when they see an image or picture, they should" read" the picture, just like it was part of the text, because it was actually replacing some of the words. Studies have shown that images aid comprehension, particularly for students who have few decoding problems but may not have sufficient background or experience to make sense of the text alone (Levin 19; Pressley 610-612; Mayer and Sims 391). Placement of the images within the text was of importance. Images were located so that students could read left to right, top to bottom and scan the images in the same method as they scanned the text. It has been noted that the placement of images relative to text plays a role in the ability of low-experience learners to improve comprehension (Mayer and Sims 391-392; Kalyuga, Chandler, and Sweller 3; Levin 22).

Students were instructed to use the appropriate keys to navigate the slides. I monitored their reading progress and administered the Chapter One post-test. Before leaving the lab at the end of the period, students in the experimental group were instructed to return directly to the lab for that same period on the following day and told that they would be doing the same type of thing but for Chapter Two.

The second day of the study, the control group reported to their regular classroom. The classroom teacher administered the Chapter Two pre-test, monitored the students' reading progress of Chapter Two, and administered the Chapter Two post-test and comprehension questions. Students who had been assigned to the computer lab reported directly to the lab at the

beginning of the class period. In the computer lab, I administered the Chapter Two pre-test, monitored the students' reading progress of Chapter Two, and administered the Chapter Two post-test and comprehension questions. In both areas, for the post-tests and comprehension questions, students were instructed that they were allowed to look back to the text if they wanted, but that it was not required. In general, the higher-level students were more prone to use this as a tool than the lower-level students. This is a skill that is emphasized in order for students to improve their score on the standardized reading tests, and so the higher-level readers likely also have a higher level of skill development in this area.

It is important to note that the classes AZ6, AZ7, and AZ8 are not native English speakers. In these classes, instructions were given in English and in Spanish by myself and the classroom teacher. Students were instructed that the important issue was to see if they had an understanding of the words. Students were instructed that they could answer the questions in Spanish if they were unable to adequately answer in English. In the other classes, there were a few students who were not native English speakers, although their English skills and reading ability were higher than the AZ classes. In those groups, I also briefly reiterated the instructions in Spanish and gave students the option of answering in Spanish. Only one of the students had a native language other than English or Spanish, but he chose to work in English, and he was part of one of the higher functioning classes. Any students who required more time than the standard class period to finish the tasks on either day were allowed to stay and continue to work for as long as was necessary. Sometimes the extra time was needed because the student had arrived late, had left for a bathroom break, or for some other extenuating circumstance. On occasion, it was simply that the student was working very diligently and needed extra time. This extra time

was not explicitly monitored but never ranged beyond an additional fifteen minutes, and the students moved on to their next class with a permission slip.

Scoring Method

In order to keep the scoring relatively simple, a scale of zero to two was used for each vocabulary word and each comprehension question. Zero points were awarded if there was no answer or if the answer was distinctly wrong. One point was awarded for a partially correct answer, or, in the case of the vocabulary words, if an alternate, but correct definition was given. An example would be if a student wrote "a flip girls do in the grass" for the word cartwheel. Giving one point for an alternate definition credited the student for understanding one meaning of the word. Still, if the student used the correct, contextual definition on the post-test the award of two point would quantitatively measure improvement.

To verify that the judgment of answers was done correctly and consistently, I scored all the answer sheets, and then had each of the classroom teachers read through and mark the answer sheets for their students. This served the purposes of both enhanced validity and increased reliability. This allowed for corrections of misunderstood handwriting problems, clarification of non-English answers, and a check for consistency in the selection of allowable answers. All answer sheet scores were checked by classroom teachers with the resulting score being agreed upon by the teacher and myself before being entered into a spreadsheet for analysis.

The results of the study and the statistical analysis of the data is the subject of Chapter Four.

CHAPTER 4 –ANALYSIS AND RESULTS

Analysis

Data

It seemed to the researcher at first that the data collected from the participants in this study would be straightforward and clear. The students either did well or did not do well, and the difference between the groups using the control method and the experimental method (if a difference existed) would be readily apparent. Such was not the case. In today's classrooms, the lack of homogeneity is laudable in the sense that very few students are isolated due to any particular trait, whether it is a learning disability, academic skill, or emotional disorder. This group of 124 subjects represents a broad spectrum of today's students. The group includes a variety of levels of English language learners (non-native speakers), a collection of learning disabilities, and a range of ages blended together into grade level classes due to retention, delayed development, or other factors.

The raw data from the students' test scores is included in the appendix. On Day One of the study, each student was given a pre-test of ten vocabulary words, asked to read Chapter One, and then given a post-test of the same ten vocabulary words in a different order. On Day Two of the study, the students repeated the process with ten different words, using Chapter Two, but also completed five comprehension questions about the story.

Student data was collected and recorded on a per-word level. This means that each student's score for each definition attempted was recorded, on a scale of zero to two, with zero being completely wrong or missing, one being partially correct or an alternate definition, and two being the correct definition according to the text used in the study. Each student's score for each comprehension question was also scored from zero to two, with zero being a wrong or missing answer, one being partially correct, and two being a correct answer. This gives 45 fields of raw data—two for each vocabulary word (pre and post), and one for each comprehension question.

The data also includes ethnicity, gender, language status, learning disability status, and the study group to which the subject was assigned. Other fields were calculated, such as the delta of each word for each student. Also calculated was the overall score for each student on the pre-test, the overall score for each student on the post-test, the delta of these two scores for each chapter, and the overall score on the comprehension questions.

Variables

In the analysis of the data, the following factors were considered. First, the data was sorted into the control (Group A) and experimental (Group C) groups. Then each group was further sorted by the descriptors below. This enabled a more detailed analysis to verify what impact, if any, these factors, or combinations of these factors, had with regard to the results of each method. Initially, 124 students fit the parameters of the study. Calculations are based on the change in performance (the delta of the scores). If any student had incomplete data, due to absence or other circumstances preventing them from fully participating, his or her information was eliminated from the statistical calculations, which left 109 students' data for analysis.

Table 2. Demographic designations that were considered in the analysis of the student results.

Demographic Designation	Description of Designation	Division of Subjects Within Designation
Group	Division of subjects for this study	Group A (control group – read from text), Group C (experimental group – read modified version from computer)
Gender	Gender of subject	Male (M) or Female (F)
LY/NLY	Language status of subject	Language Learner (LY), Proficient or Native Speaker (NLY)
ESE/NESE	Learning disability status of subject	Documented learning disability (ESE), no known learning disability (NESE)
NLYwNESE NLYwESE LYwNESE LYwESE	Language status in combination with learning disability status	These combinations were examined in order to better understand the extent of the effect of these factors

Table 3. Number of subjects in each group, for each analysis set.

Type	Group A	Group C
M	34	33
F	22	20
LY	24	27
NLY	32	26
ESE	18	18
NESE	38	35
NLYwNESE	21	15
NLYwESE	11	11
LYwNESE	17	20
LYwESE	7	7

Ultimately, the analysis was run for the overall data of the control group versus the experimental group, as well as the following subsets: male (M), female (F), language learners (LY), proficient/native speakers (NLY), students with learning disabilities (ESE), students without learning disabilities (NESE), language learners including students with learning disabilities (LYwESE), language learners excluding students with learning disabilities (LYwNESE), proficient/native speakers including students with learning disabilities

(NLYwESE), and proficient/native speakers excluding students with learning disabilities (NLYwNESE). Table 2 above gives an overview of these variables, their designation, description, and how the subjects were divided. The first column contains the designation of the categories. The second column notes the meaning of the designation, while the final column identifies the specific demographic divisions.

Method

The paired t-test and two-sample t-test were performed on the subsets of the data. This form of analysis showed that, for the majority of the subgroups, the experimental format was at least as effective as the control format. There were instances when the experimental performed better than the control. Also, there are a few instances when the p-value of the experimental format is less than 0.10, which would easily have been statistically significant within a 90% confidence interval. Notably, in the subset of students with learning disabilities, the experimental version performed better than the text only version for Chapter One. Later analysis of language learners (LY) with learning disabilities (ESE), it can be seen that only the experimental method showed growth, and only for Chapter One.

The results of each subgroup and test are thoroughly discussed below. The program used to compute the data was Minitab version 15.1.30.0. For every analysis set (as listed in table 3, above), six tests were run. Test one is a paired t-test of the results of the control group (Group A) for Chapter One. Test two is a paired t-test of the results of the control group for Chapter Two. Test three is a paired t-test of the results of the experimental group (Group C) for Chapter One, and test four is the final paired t-test, using the data from the experimental group for Chapter Two. Test five is a two-sample t-test comparing the performance of the experimental group and

the control group using the delta (the post-test less the pre-test) to compare the results from Chapter One. Test six is a two-sample t-test comparing the performance of the experimental group and the control group using the delta from the pre-test to the post-test to compare the results from Chapter Two.

Hypothesis

This study was based on the foundation of research in a variety of fields. The literature review fostered an understanding of language development, along with the coding and decoding necessary for reading. This compilation was blended with the study of symbols, images, and cognitive load theory. For the paired t-tests, the null hypothesis (H_0) for this research states that for each group (Group A and Group C), the post-test scores for each chapter (Chapter One and Chapter Two) less the pre-test scores for each respective chapter will equal zero. In simpler terms, the students will not show improvement between the pre- to the post-test scores, when looked at by group and separated by chapter. Such that, where μ→mean, for each chapter, for each group:

$$H_0 : \mu_{pre} = \mu_{post}$$

The alternative hypothesis (H_a), which would be accepted if the results reject the null hypothesis, can be stated as follows: For each group (Group A and Group C), the post-test scores for each chapter (Chapter One and Chapter Two) less the pre-test scores for each respective chapter will be greater than zero. Stated simply, the students' post-test scores will be higher than their pre-test scores, when looked at by group and separated by chapter. Such that, where μ→mean, for each chapter, for each group:

$$H_a : \mu_{pre} < \mu_{post}$$

Since tests five and six are two-sample t-tests, the equation is modified and can be described such that for each group, for each chapter where μ→mean

$$H_0 : \mu_{\Delta GroupC} = \mu_{\Delta GroupA}$$
$$H_a : \mu_{\Delta GroupA} < \mu_{\Delta GroupC}$$

Reading the Output

Below are the results of the analyses performed. All the tests were performed with an alpha of 95. The statistically relevant results are those where the p-value is less than 0.05. At the end of this chapter, there is a summary shown in table 4, listing each test, the p-value, and with a column showing the effect size.

Six tests were performed for each data set. Tests one, two, three, and four are paired t-tests. The results of these tests are shown in box plots. In each of these plots, the gray box represents the bulk of the data points. The left side of the box begins at the twenty-fifth percentile of the data, and the right side of the box represents the seventy-fifth percentile of the data. The vertical black line inside the box is the median of the data. Below the gray box, the circle is positioned at the value of zero. The arrow line denotes the results, using the 95% confidence interval. The left edge of the arrow line is the lower bound of the confidence interval. If the arrow line is to the right of the dot (greater than zero), then the results reject the null hypothesis.

For each of the paired t-tests, the data is given in a table. For the column headings, *N* is the number of subjects, *Mean* is the average of the scores, *St Dev* is the standard deviation of the scores, and *SE Mean* is the standard error of the mean. The groups are specified in the first

column. For example, in the first set of results below, the first column for the first row of data is labeled *Group A Chapter 1 Post*, which means the post-test scores of the subjects in the control group on Chapter One. The labels are consistent throughout each of the subgroups.

Tests five and six are two-sample t-tests and show comparisons between the control (Group A) and the experimental group (Group C), for each chapter. These results are displayed as histograms where each data point is shown in the cluster for each group. The circle in each grouping is the mean of each sample. For these analyses, we look at the average delta (the average of all the post-test scores less the pre-test scores) for Group C for a single chapter, less the average delta for Group A for the same chapter. Then the p-value is calculated. If the p-value is less than 0.05, the null hypothesis is rejected.

Results

Overall, both reading formats (the control and the experimental) show growth in both chapters, except for a few combinations. The first demographic division that shows a difference is the students with learning disabilities (ESE). Here, the control group (Group A) does not show statistical growth for Chapter One. Also in this division, in the two-sample t-test for Chapter One, the experimental group shows statistically significant improvement over the control group. This means the experimental reading format of text combined with images definitely demonstrates an impact for the ESE students, but further differentiation was needed. In the demographic division for the proficient/native speakers who had learning disabilities (NLYwESE), the control group (Group A) for Chapter One did not show statistical growth. This conforms to the finding from the larger, ESE group. However, the language learners who have learning disabilities (LYwESE) definitely struggled the most. These students only demonstrated

statistically significant progress in the experimental reading format, and only for Chapter One, which presents almost all of the vocabulary words explicitly in images as well as in the text.

In calculating the effect size of the study results, almost all of the possible combinations demonstrate a large effect. The strongest effect size is seen in the experimental format for Chapter One by the native / proficient English speakers – both with learning disabilities (NLYwESE: $r = 0.816$) and without learning disabilities (NLYwNESE: $r = 0.842$). More interestingly, the largest difference in effect size within subgroups is for those students with learning disabilities. In this demographic (ESE), for Chapter One, the experimental version shows an effect size of 0.497 *greater* than the control version. Within this demographic, the effect size for the native / proficient English speakers who have a learning disability (NLYwESE), for Chapter One, shows an effect size of 0.409 *larger* for the experimental version, while the language learners with a learning disability (LYwESE), for Chapter One, show an effect size of 0.724 *larger* for the experimental version.

Below is an analytical breakdown by each group and subgroup. At the end of this chapter is an overview table which shows each category the p-value, and effect size.

All Subjects

When comparing the data for all subjects involved in the study, we see growth for the students, in both chapters, for each of the methods of reading. Below are the results for each group, for each chapter. The first table and boxplot show the results for the control group (Group A) for Chapter One. The second table and boxplot show the results for Group A for Chapter Two. The third set shows the results for the experimental group (Group C) for Chapter One. The results of Group C for Chapter Two are seen in the fourth set. As you can see in the first dataset, the null hypothesis is rejected with the p-value of 0.000. In fact, the null hypothesis is rejected for all four of the paired t-tests when the subjects are simply separated into the control and experimental groups.

One notable result in this group is the lower bound for the mean difference in the experimental group (Group C) in the results for Chapter One. This mean difference is 2.694, which is much larger than the mean difference for the other three. This implies that, although growth is seen in both reading methods for both chapters, the subjects in the experimental format performed at a higher level in the reading of Chapter One. The experimental version of Chapter One contains nine of the ten vocabulary words explicitly depicted in images. Although this alone is not sufficient to draw conclusions about the value of imagery for vocabulary acquisition, it lends value to the results of the more in-depth analyses, and in retrospect can be seen as a signpost. The fact that this evidence is clearly seen in the very heterogeneous grouping of subjects also lends weight to the value of imagery as a learning tool for all students.

ALL	N	Mean	St Dev	S E Mean
GP A chp 1 Post	56	13.214	4.381	0.585
GP A chp 2 Pre	56	10.643	4.020	0.537
Difference	56	2.571	3.818	0.510

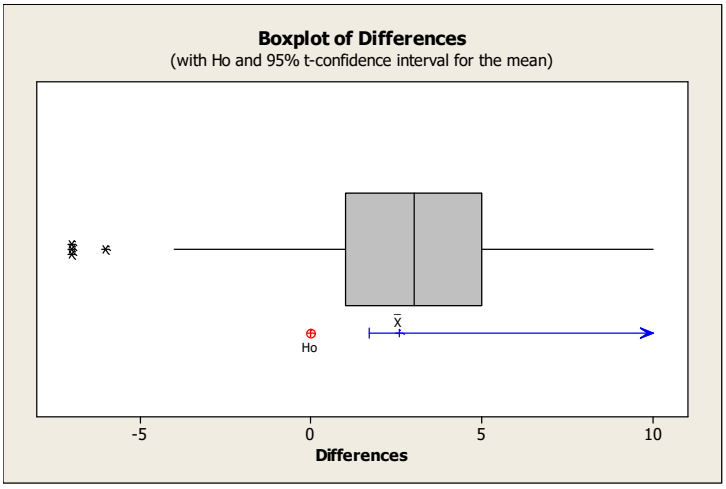


Figure 18. All Subjects - Paired T-Test and CI: Group A Chapter 1 Post-test, Group A Chapter 1 Pre-test; 95% lower bound for mean difference: 1.718; T-Test of mean difference = 0 (vs > 0): T-Value = 5.04 P-Value = 0.000

ALL	N	Mean	StDev	SE Mean
GP A chp 2 post	56	9.268	4.283	0.572
GP A chp 2 pre	56	7.000	3.823	0.511
Difference	56	2.268	2.401	0.321

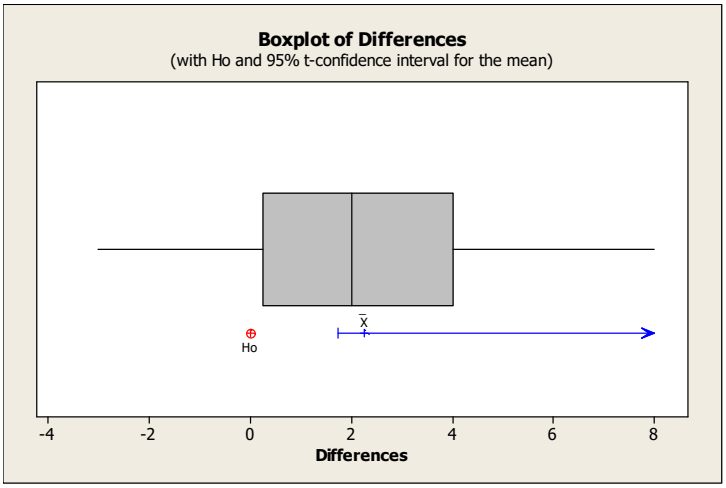


Figure 19. All Subjects - Paired T-Test and CI: Group A Chapter 2 Post-test, Group A Chapter 2 Pre-test; 95% lower bound for mean difference: 1.731; T-Test of mean difference = 0 (vs > 0): T-Value = 7.07 P-Value = 0.000

ALL	N	Mean	StDev	SE Mean
GP C chp 1 post	53	12.642	4.872	0.669
GP C chp 1 pre	53	9.321	4.287	0.589
Difference	53	3.321	2.723	0.374

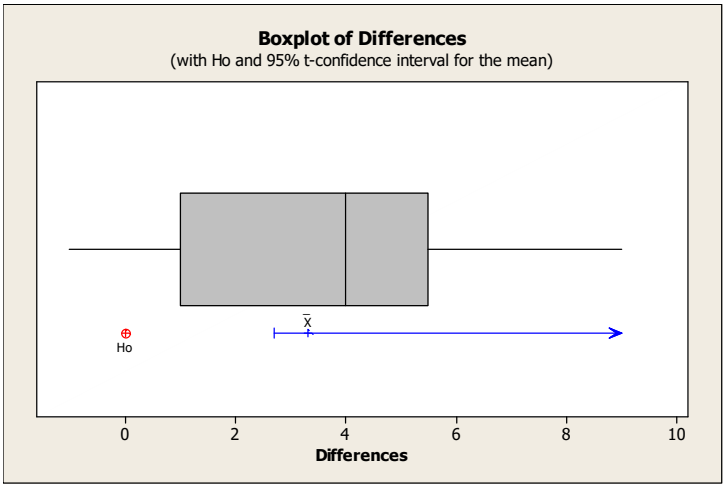


Figure 20. All Subjects - Paired T-Test and CI: Group C Chapter 1 Post-test, Group C Chapter 1 Pre-test; 95% lower bound for mean difference: 2.694; T-Test of mean difference = 0 (vs > 0): T-Value = 8.88 P-Value = 0.000

ALL	N	Mean	StDev	SE Mean
GP C chp 2 post	53	7.887	3.851	0.529
GP C chp 2 pre	53	5.717	3.116	0.428
Difference	53	2.170	2.847	0.391

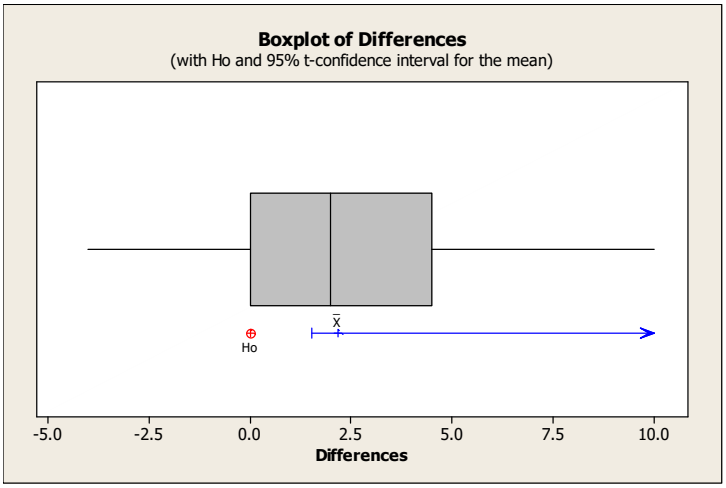


Figure 21. All Subjects - Paired T-Test and CI: Group C Chapter 2 Post-test, Group C Chapter 2 Pre-test; 95% lower bound for mean difference: 1.515; T-Test of mean difference = 0 (vs > 0): T-Value = 5.55 P-Value = 0.000.

ALL	N	Mean	StDev	SE Mean
GP C d chp 1	53	3.32	2.72	0.37
GP A d chp 1	56	2.57	3.82	0.51

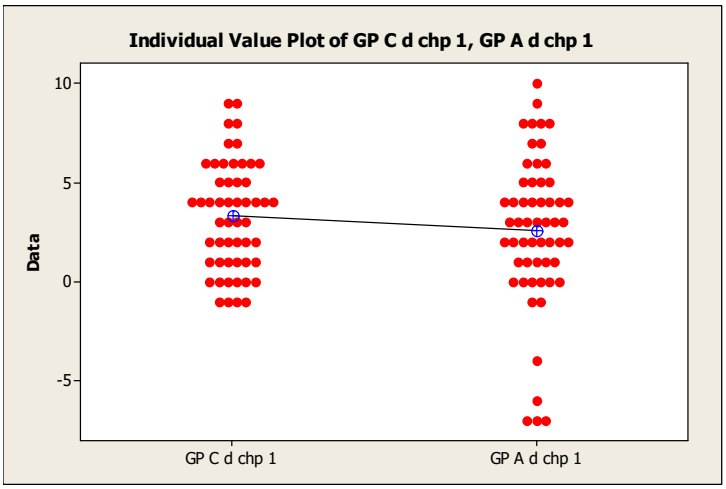


Figure 22. All Subjects - Two-Sample T-Test and CI: Group C Delta Chapter 1, Group A Delta Chapter 1; Difference = mu (GP C d chp 1) - mu (GP A d chp 1); Estimate for difference: 0.749; 95% lower bound for difference: -0.301; T-Test of difference = 0 (vs. >): T-Value =1.18 P-Value = 0.120 DF = 99.

ALL	N	Mean	StDev	SE Mean
GP C d chp 2	53	2.17	2.85	0.39
GP A d chp 2	56	2.27	2.40	0.32

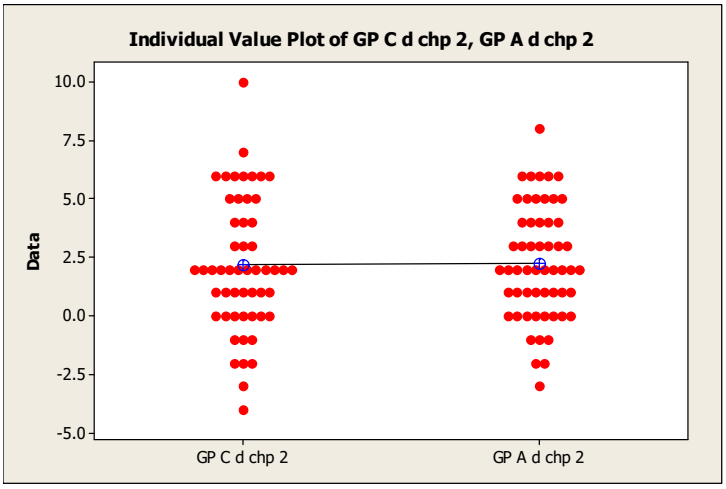


Figure 23. All Subjects - Two-Sample T-Test and CI: Group C Delta Chapter 2, Group A Delta Chapter 2; Difference = mu (GP C d chp 2) - mu (GP A d chp 2); Estimate for difference: -0.098; 95% lower bound for difference: -0.938;T-Test of difference = (vs. >): T-Value = -0.19 P-Value = 0.577 DF = 101.

Above are tests five and six, which examine the difference between the deltas of the experimental and control groups for each chapter (the post-test scores for each chapter, less the pre-test scores for each chapter). The first compares the results from the experimental group and control group for Chapter One. The second looks at the difference in performance between the two groups for Chapter Two. The delta is calculated by taking each subject's post-test score, less that subject's pre-test score for each chapter. Then those delta scores are averaged, and the experimental group is compared to the control group for each chapter. For these tests, the p-value is not less than 0.05. This means there is no statistical difference between the two groups, and the null hypothesis is accepted.

At this point in the analysis, little else can be seen from the data. Therefore, a deeper analysis was conducted, using the possible combinations of language status and learning disability status.

Below, the first level of subgroups and their results are shown. Because the study subjects were sub-divided into more specific subgroups for more thorough examination, the numbers of subjects involved in the analysis altered. Within each subgroup description and analysis, the numbers of subjects in the control and experimental sections are listed. Analysis at this level does limit the number of study subjects for statistical computations. However, this is much more interesting as it allows us to focus on the impact of the two reading formats for particular demographic divisions and combinations of those divisions. Each section contains the description of the division category, and the number of subject that comprised that category.

Results by First Level Subgroups

Females/Males

Below, the results of the entire sample are divided into males and females. Group A was the control group who read from the book. Group C was the experimental group who read from the computer with images. In this study, the ratio of males to females was 67:42 or 61% males and 39% females.

In the categories of males and females, growth occurred in vocabulary for both groups in both chapters. This allows the rejection of the null hypothesis. This demonstrates that both methods resulted in a positive effect for females as well as males.

Females

Studies on gender issues in reading have shown that girls tend to score better in areas of literacy and are more likely to read for personal pleasure (Klecker 50-51). Often, due to early development of verbal abilities, girls receive more attention and verbal interaction with parents or caregivers (Siegler, DeLoache and Eisenberg 592). This early development of articulation skills has also been linked to stronger vocabulary and reading skills (Baddeley 155). This is likely the reason for the lower percentage of females in these particular reading classes. For this subgroup, the effect sizes were large, with the most notable being Chapter One for the experimental version where $r = 0.819$.

FEMALES	N	Mean	StDev	SE Mean
GP A chp 1 post	22	13.955	4.370	0.932
GP A chp 1 pre	22	10.864	4.015	0.856
Difference	22	3.091	4.208	0.897

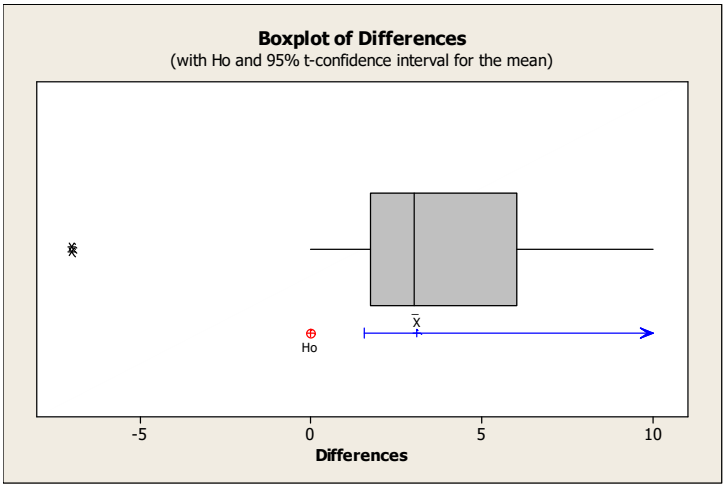


Figure 24. Females - Paired T-Test and CI: Group A Chapter 1 Post-test, Group A Chapter 1 Pre-test; 95% lower bound for mean difference: 1.547; T-Test of mean difference = 0 (vs > 0): T-Value = 3.45 P-Value = 0.001; r = 0.601.

FEMALES	N	Mean	StDev	SE Mean
GP A chp 2 post	22	9.318	3.695	0.788
GP A chp 2 pre	22	7.273	3.269	0.697
Difference	22	2.045	2.554	0.544

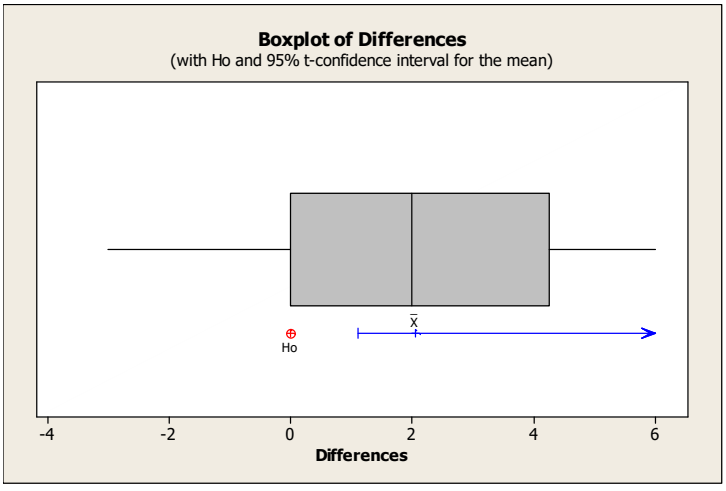


Figure 25. Females - Paired T-Test and CI: Group A Chapter 2 Post-test, Group A Chapter 2 Pre-test; 95% lower bound for mean difference: 1.109; T-Test of mean difference = 0 (vs > 0): T-Value = 3.76 P-Value = 0.001; r = 0.634.

FEMALES	N	Mean	StDev	SE Mean
GP C chp 1 post	20	12.25	5.09	1.14
GP C chp 1 pre	20	9.00	4.58	1.02
Difference	20	3.250	2.337	0.523

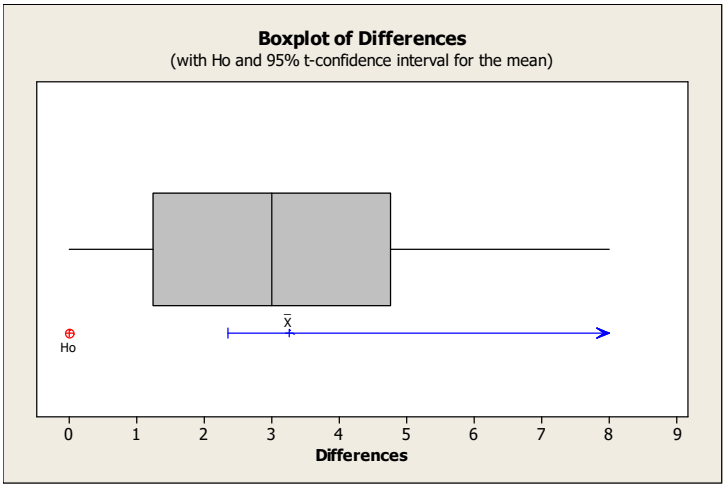


Figure 26. Females - Paired T-Test and CI: Group C Chapter 1 Post-test, Group C Chapter 1 Pre-test; 95% lower bound for mean difference: 2.346; T-Test of mean difference = 0 (vs > 0): T-Value = 6.22 P-Value = 0.000; r = 0.819.

FEMALES	N	Mean	StDev	SE Mean
GP C chp 2 post	20	7.400	3.331	0.745
GP C chp 2 pre	20	5.050	2.781	0.622
Difference	20	2.350	3.048	0.682

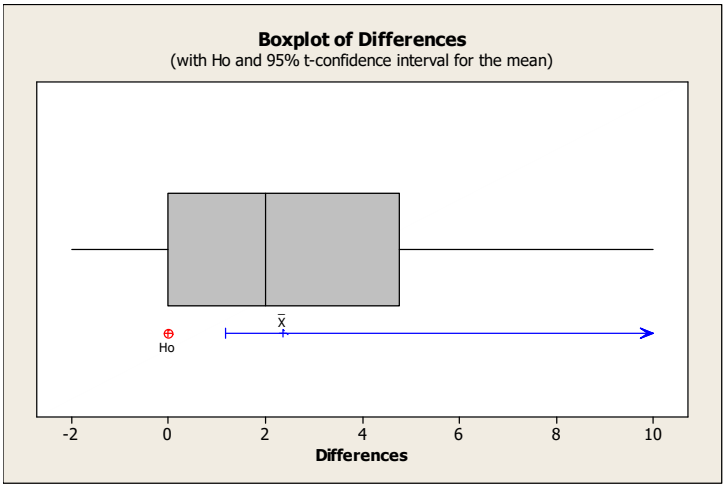


Figure 27. Females - Paired T-Test and CI: Group C Chapter 2 Post-test, Group C Chapter 2 Pre-test; 95% lower bound for mean difference: 1.171; T-Test of mean difference = 0 (vs > 0): T-Value = 3.45 P-Value = 0.001; r = 0.621.

FEMALES	N	Mean	StDev	SE Mean
GP C d chp 1	20	3.25	2.34	0.52
GP A d chp 1	22	3.09	4.21	0.90

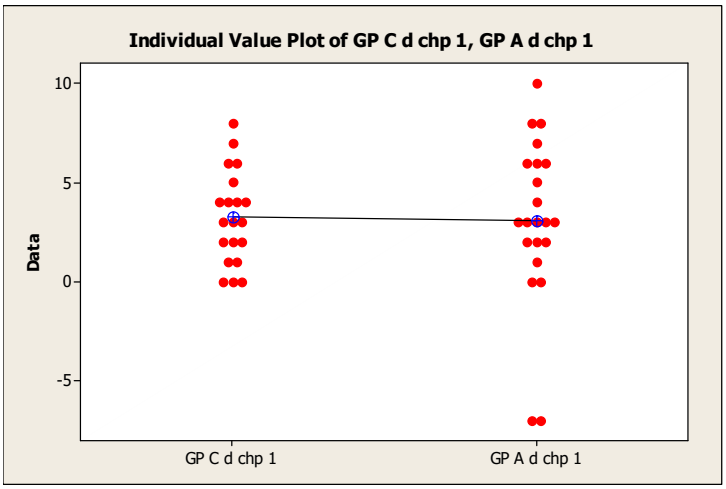


Figure 28. Females - Two-Sample T-Test and CI: Group C Delta Chapter 1, Group A Delta Chapter 1; Difference = mu (GP C d chp 1) - mu (GP A d chp 1); Estimate for difference: 0.16; 95% lower bound for difference: -1.60; T-Test of difference = 0 (vs >):T-Value = 0.15 P-Value = 0.440 DF = 33.

FEMALES	N	Mean	StDev	SE Mean
GP C d chp 2	20	2.35	3.05	0.68
GP A d chp 2	22	2.05	2.55	0.54

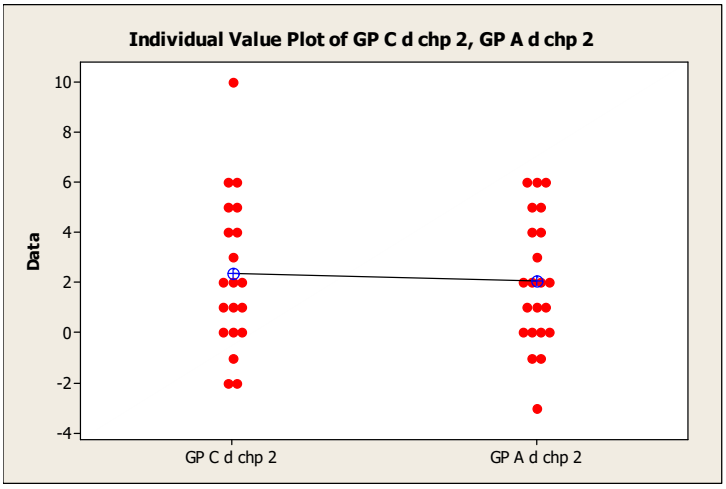


Figure 29. Females - Two-Sample T-Test and CI: Group C Delta Chapter 2, Group A Delta Chapter 2 Difference = mu (GP C d chp 2) - mu (GP A d chp 2); Estimate for difference: 0.305; 95% lower bound for difference: -1.167; T-Test of difference = 0 (vs >): T-Value = 0.35 P-Value = 0.364 DF = 37.

Males

The higher ratio of males to females assigned to the reading classes used in this study is to be expected. Statistics from the 2009 Nation's Report Card show that nationally, there are eight percent more males below the basic reading level than females. In this same document, Florida is shown as having ten percent more males below basic reading proficiency than females (Nation's Report Card 66). In this study, there were approximately twenty percent more males than females. However, it is also encouraging to see that both genders performed in a positive manner during this trial, showing growth in vocabulary.

MALES	N	Mean	StDev	SE Mean
GP A chp 1 post	34	12.735	4.385	0.752
GP A chp 1 pre	34	10.500	4.077	0.699
Difference	34	2.235	3.568	0.612

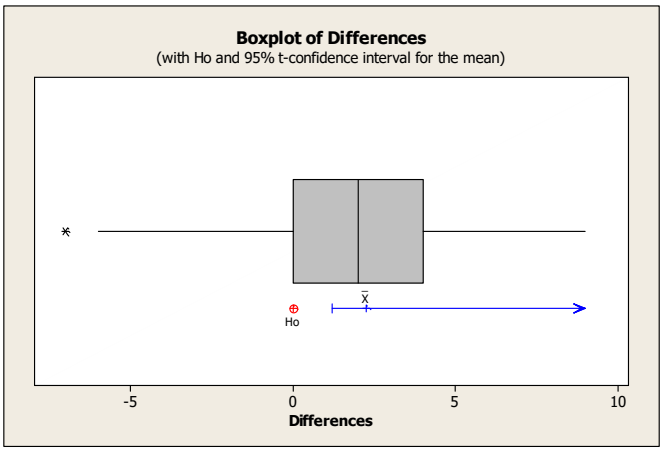


Figure 30. Males - Paired T-Test and CI: Group A Chapter 1 Post-test, Group A Chapter 1 Pre-test; 95% lower bound for mean difference: 1.200; T-Test of mean difference = 0 (vs > 0): T-Value = 3.65 P-Value = 0.000; r = 0.536.

MALES	N	Mean	StDev	SE Mean
GP A chp 2 post	34	9.235	4.678	0.802
GP A chp 2 pre	34	6.824	4.181	0.717
Difference	34	2.412	2.324	0.399

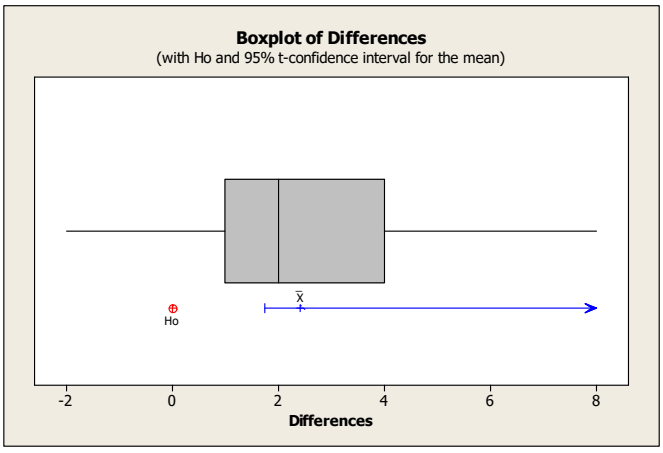


Figure 31. Males - Paired T-Test and CI: Group A Chapter 2 Post-test, Group A Chapter 2 Pre-test; 95% lower bound for mean difference: 1.737; T-Test of mean difference = 0 (vs > 0): T-Value = 6.05 P-Value = 0.000; r = 0.725.

MALES	N	Mean	StDev	SE Mean
GP C chp 1 post	33	12.879	4.801	0.836
GP C chp 1 pre	33	9.515	4.162	0.724
Difference	33	3.364	2.967	0.516

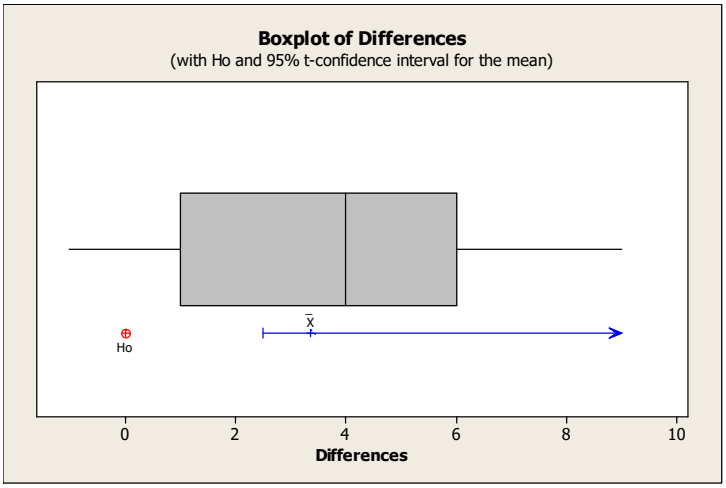


Figure 32. Males - Paired T-Test and CI: Group C Chapter 1 Post-test, Group C Chapter 1 Pre-test; 95% lower bound for mean difference: 2.489; T-Test of mean difference = 0 (vs > 0): T-Value = 6.51 P-Value = 0.000; r = 0.755.

MALES	N	Mean	StDev	SE Mean
GP C chp 2 post	33	8.182	4.157	0.724
GP C chp 2 pre	33	6.121	3.276	0.570
Difference	33	2.061	2.761	0.481

Figure 33. Males - Paired T-Test and CI: Group C Chapter 2 Post-test, Group C Chapter 2 Pre-test; 95% lower bound for mean difference: 1.247; T-Test of mean difference = 0 (vs > 0): T-Value = 4.29 P-Value = 0.000; r = 0.604.

MALES	N	Mean	StDev	SE Mean
GP C d chp 1	33	3.36	2.97	0.52
GP A d chp 1	34	2.24	3.57	0.61

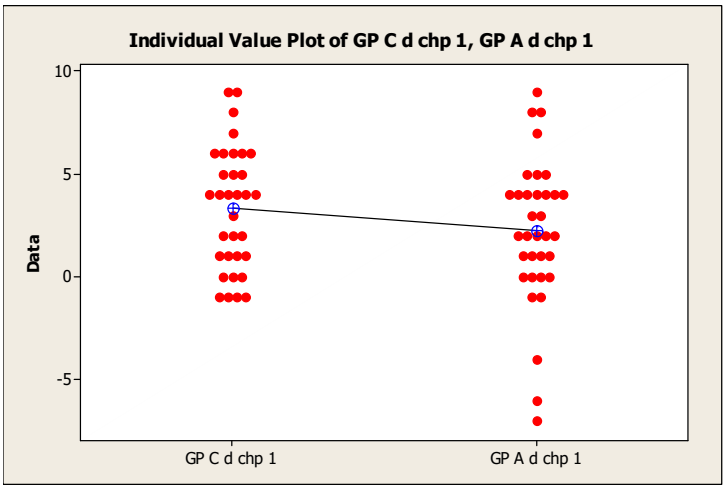


Figure 34. Males - Two-Sample T-Test and CI: Group C Delta Chapter 1, Group A Delta Chapter 1; Difference = mu (GP C d chp 1) - mu (GP A d chp 1); Estimate for difference: 1.128; 95% lower bound for difference: -0.208; T-Test of difference = 0 (vs >): T-Value = 1.41 P-Value = 0.82 DF = 63.

MALES	N	Mean	StDev	SE Mean
GP C d chp 2	33	2.06	2.76	0.48
GP A d chp 2	34	2.41	2.32	0.40

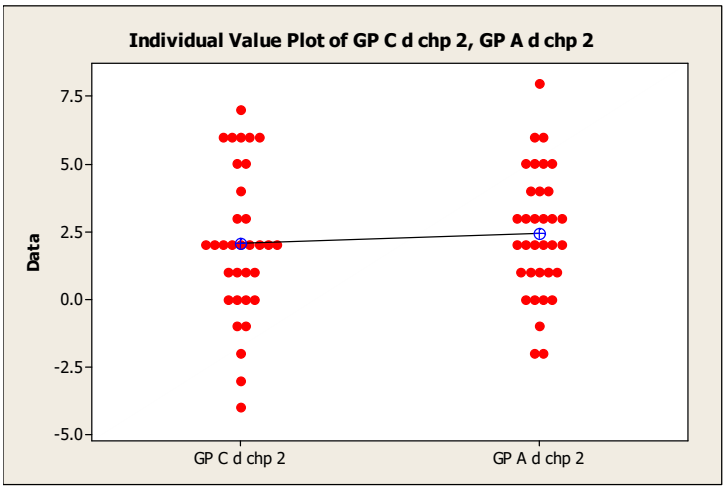


Figure 35. Males - Two-Sample T-Test and CI: Group C Delta Chapter 2, Group A Delta Chapter 2; Difference = mu (GP C d chp 2) - mu (GP A d chp 2); Estimate for difference: -0.351; 95% lower bound for difference: -1.394; T-Test of difference = 0 (vs >): T-Value = -0.56 P-Value = 0.712 DF = 62.

LY/NLY

Below are the results, at 95% confidence interval, of the entire sample, for the categories of language learners (LY) and proficient/native speakers (NLY). Group A was the control group who read from the book. Group C was the experimental group who read from the computer with images.

With the students segregated by language skills where language learners (LY) are separated from proficient/native speakers (NLY), both methods show growth in vocabulary for both chapters, and the null hypothesis is rejected. This again demonstrates that both methods are statistically similar. The ratio of language learners to proficient/native speakers is 51:58 or 43% to 57%. In the LY division, Group A had 24 students; Group C had 27 students. In the NLY division, Group A had 32 students, while Group C had 26.

LY

These are students who are language learners who ranged from less than a year to over three years as English language learners. Interestingly, two recent studies in the area of language learners and the use of images with text have contradictory results. This could be due to the vast array of levels, experience, ages, and backgrounds involved when studying language learners in the typical school setting. One study conducted in 2009 in a secondary, language-learner Life Sciences class, showed that the students performed better when given textual notes from an overhead, than when the notes were given with color images as illustrations (Tu 41-42). While another study from 2008, (with students aged 20-27 years), showed that the use of multimedia improved performance on vocabulary (Erdemir 54). The results of the present study show similar results for both the control (text only) and the experimental (text with images) reading formats.

LY	N	Mean	StDev	SE Mean
GP A chp 1 post	24	12.167	3.953	0.807
GP A chp 1 pre	24	9.875	3.530	0.721
Difference	24	2.292	3.917	0.800

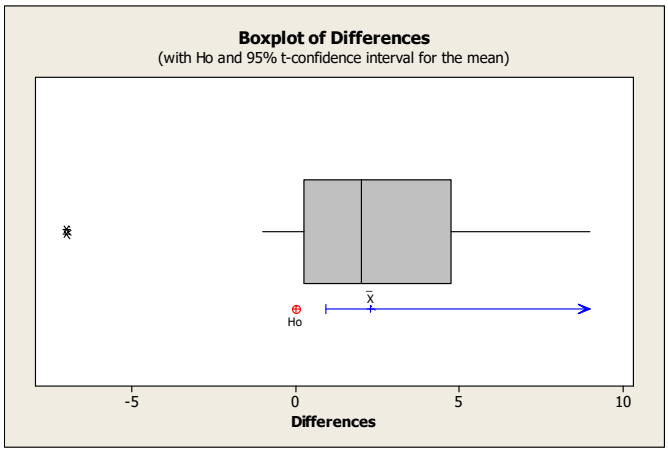


Figure 36. LY - Paired T-Test and CI: Group A Chapter 1 Post-test, Group A Chapter 1 Pre-test; 95% lower bound for mean difference: 0.921; T-Test of mean difference = 0 (vs > 0): T-Value = 2.87 P-Value = 0.004; r = 0.514.

LY	N	Mean	StDev	SE Mean
GP A chp 2 post	24	7.167	3.212	0.656
GP A chp 2 pre	24	5.250	3.300	0.674
Difference	24	1.917	1.863	0.380

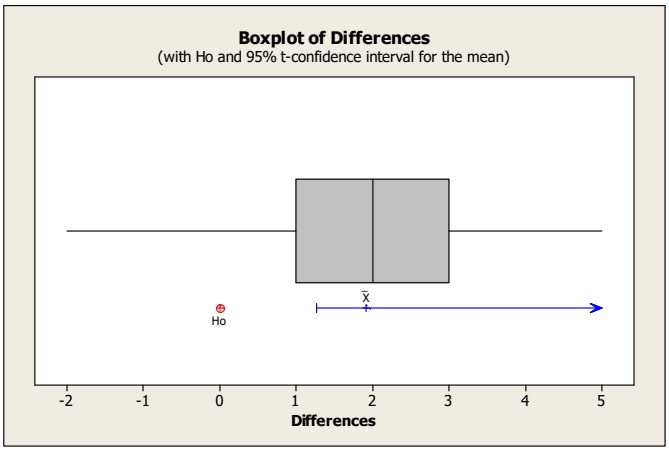


Figure 37. LY - Paired T-Test and CI: Group A Chapter 2 Post-test, Group A Chapter 2 Pre-test; 95% lower bound for mean difference: 1.265; T-Test of mean difference = 0 (vs > 0): T-Value = 5.04 P-Value = 0.00; r = 0.724.

LY	N	Mean	StDev	SE Mean
GP C chp 1 post	27	11.11	5.52	1.06
GP C chp 1 pre	27	8.15	4.79	0.92
Difference	27	2.963	2.902	0.558

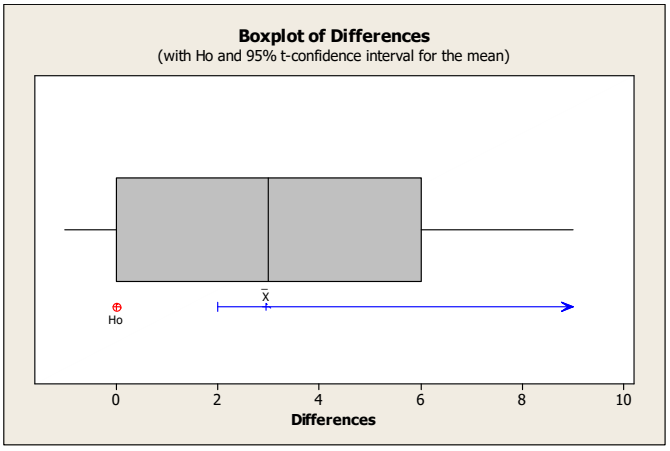


Figure 38. LY - Paired T-Test and CI: Group C Chapter 1 Post-test, Group C Chapter 1 Pre-test; 95% lower bound for mean difference: 2.010; T-Test of mean difference = 0 (vs > 0): T-Value = 5.31 P-Value = 0.000; r = 0.721.

LY	N	Mean	StDev	SE Mean
GP C chp 2 post	27	5.889	2.979	0.573
GP C chp 2 pre	27	4.407	2.099	0.404
Difference	27	1.481	2.666	0.513

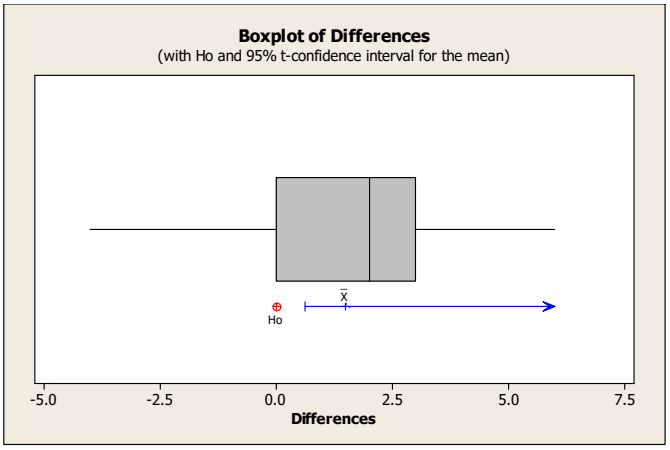


Figure 39. LY - Paired T-Test and CI: Group C Chapter 2 Post-test, Group C Chapter 2 Pre-test; 95% lower bound for mean difference: 0.607; T-Test of mean difference = 0 (vs > 0): T-Value = 2.89 P-Value = 0.004; r = 0.493.

LY	N	Mean	StDev	SE Mean
GP C d chp 1	27	2.96	2.90	0.56
GP A d chp 1	24	2.29	3.92	0.80

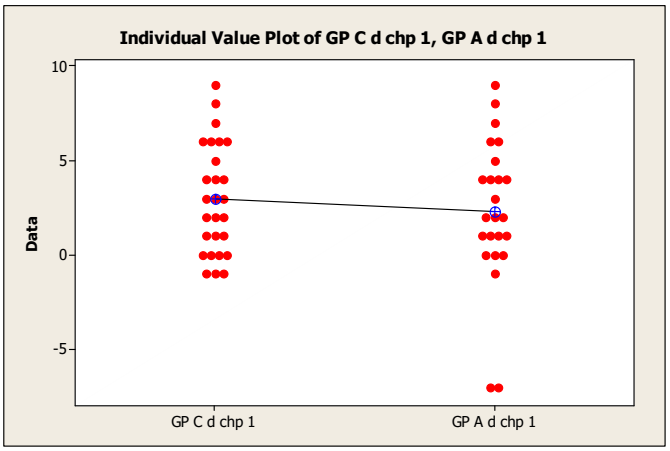


Figure 40. LY - Two-Sample T-Test and CI: Group C Delta Chapter 1, Group A Delta Chapter 1; Difference = mu (GP C d chp 1) - mu (GP A d chp 1); Estimate for difference: 0.671; 95% lower bound for difference: -0.969; T-Test of difference = 0 (vs >): T-Value = 0.69 P-Value = 0.248 DF = 42.

LY	N	Mean	StDev	SE Mean
GP C d chp 2	27	1.48	2.67	0.51
GP A d chp 2	24	1.92	1.86	0.38

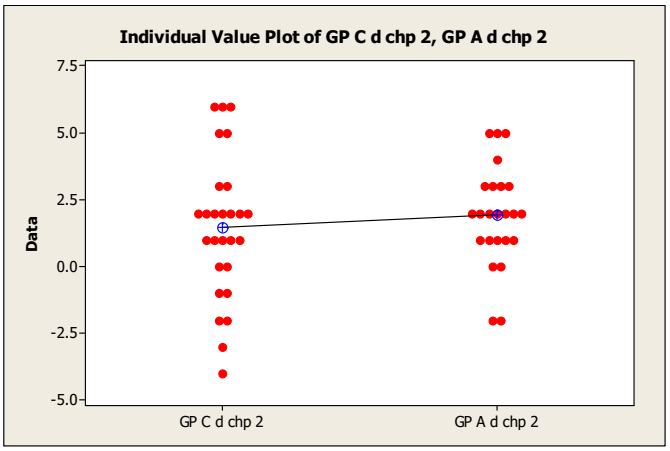


Figure 41. LY - Two-Sample T-Test and CI: Group C Delta Chapter 2, Group A Delta Chapter 2; Difference = mu (GP C d chp 2) - mu (GP A d chp 2); Estimate for difference: -0.435; 95% lower bound for difference: -1.507; T-Test of difference = 0 (vs >): T-Value = -0.68 P-Value = 0.751 DF = 46.

NLY

These are the proficient or native English speakers. In this portion of the analysis, growth is seen in both the experimental and control reading formats for both chapters. The two-sample t-test does not show a difference in the two methods for either chapter. The experimental group for Chapter One shows one of the largest effect sizes, where r = 0.830

NLY	N	Mean	StDev	SE Mean
GP A chp 1 post	32	14.000	4.579	0.809
GP A chp 1 pre	32	11.219	4.316	0.763
Difference	32	2.781	3.791	0.670

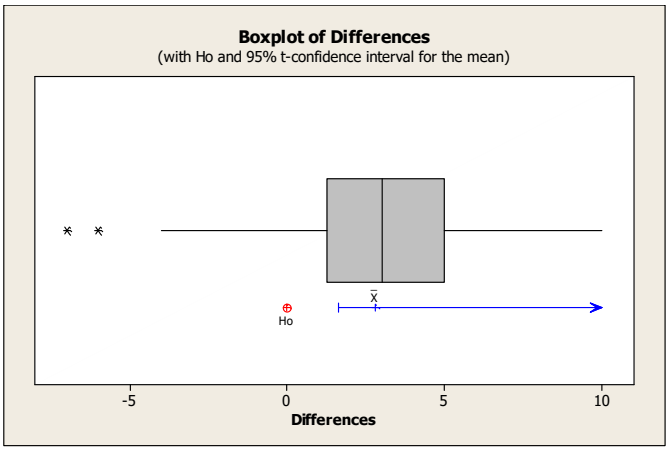


Figure 42. NLY - Paired T-Test and CI: Group A Chapter 1 Post-test, Group A Chapter 1 Pre-test; 95% lower bound for mean difference: 1.645; T-Test of mean difference = 0 (vs > 0): T-Value = 4.15 P-Value = 0.000; r = 0.598.

NLY	N	Mean	StDev	SE Mean
GP A chp 2 post	32	10.844	4.349	0.769
GP A chp 2 pre	32	8.312	3.702	0.654
Difference	32	2.531	2.735	0.484

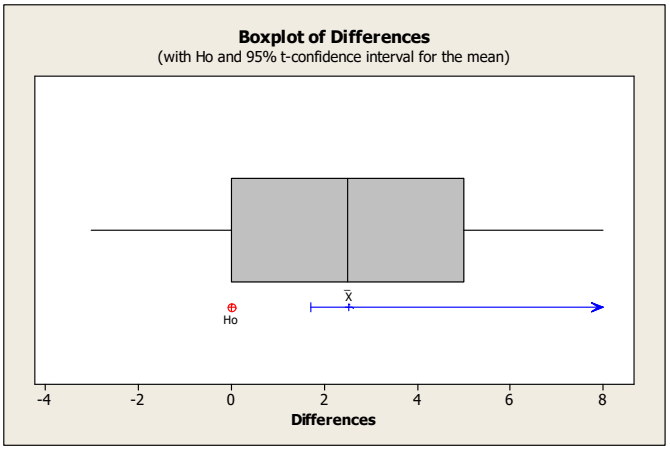


Figure 43. NLY - Paired T-Test and CI: Group A Chapter 2 Post-test, Group A Chapter 2 Pre-test; 95% lower bound for mean difference: 1.711; T-Test of mean difference = 0 (vs > 0): T-Value = 5.23 P-Value = 0.000; r = 0.685.

NLY	N	Mean	StDev	SE Mean
GP C chp 1 post	26	14.231	3.536	0.694
GP C chp 1 pre	26	10.538	3.361	0.659
Difference	26	3.692	2.526	0.495

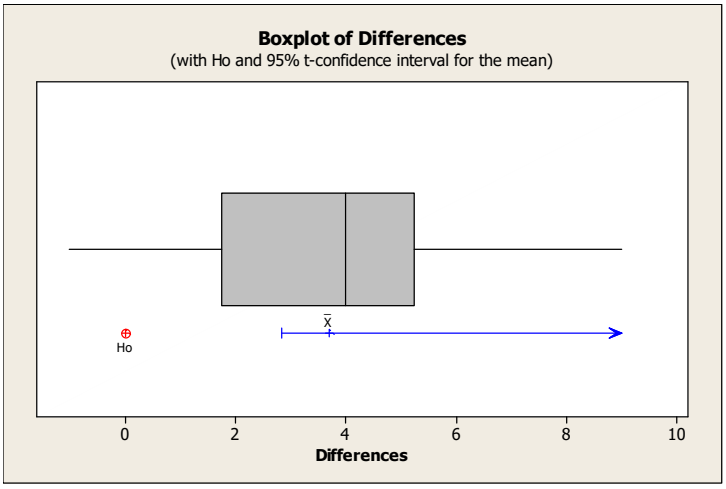


Figure 44. NLY - Paired T-Test and CI: Group C Chapter 1 Post-test, Group C Chapter 1 Pre-test; 95% lower bound for mean difference: 2.846; T-Test of mean difference = 0 (vs > 0): T-Value = 7.45 P-Value = 0.000; r = 0.830.

NLY	N	Mean	StDev	SE Mean
GP C chp 2 post	26	9.962	3.583	0.703
GP C chp 2 pre	26	7.077	3.440	0.675
Difference	26	2.885	2.903	0.569

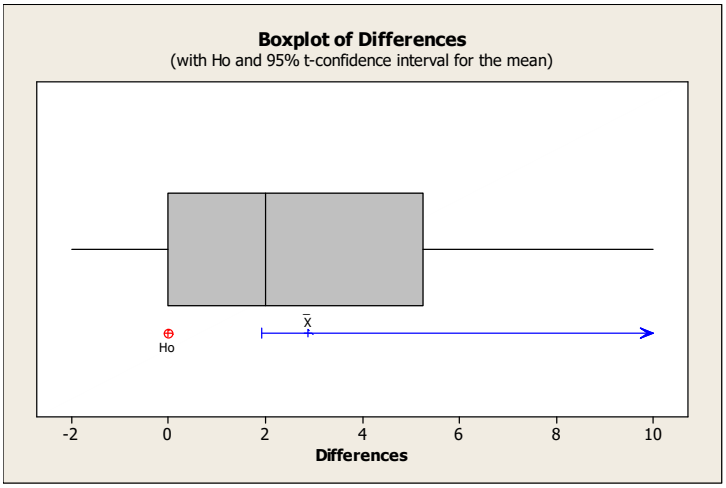


Figure 45. NLY - Paired T-Test and CI: Group C Chapter 2 Post-test, Group C Chapter 2 Pre-test; 95% lower bound for mean difference: 1.912; T-Test of mean difference = 0 (vs > 0): T-Value = 5.07 P-Value = 0.000; r = 0.712.

NLY	N	Mean	StDev	SE Mean
GP C d chp 1	26	3.69	2.53	0.50
GP A d chp 1	32	2.78	3.79	0.67

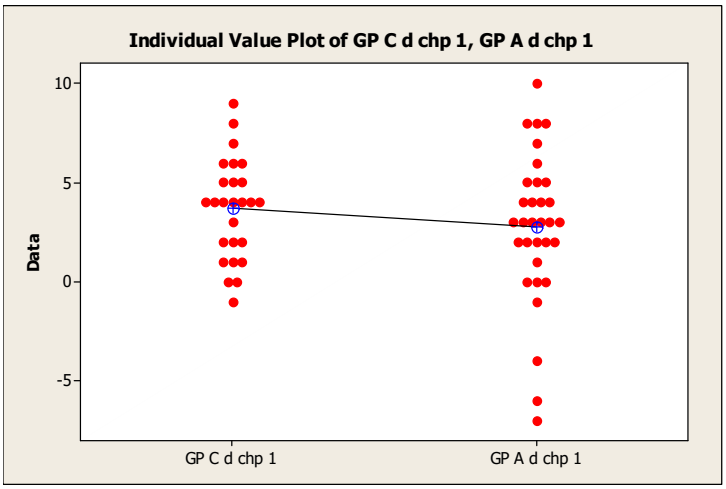


Figure 46. NLY - Two-Sample T-Test and CI: Group C Delta Chapter 1, Group A Delta Chapter 1; Difference = mu (GP C d chp 1) - mu (GP A d chp 1); Estimate for difference: 0.911; 95% lower bound for difference: -0.484; T-Test of difference = 0 (vs >): T-Value = 1.09 P-Value = 0.140 DF = 54.

NLY	N	Mean	StDev	SE Mean
GP C d chp 2	26	2.88	2.90	0.57
GP A d chp 2	32	2.53	2.74	0.48

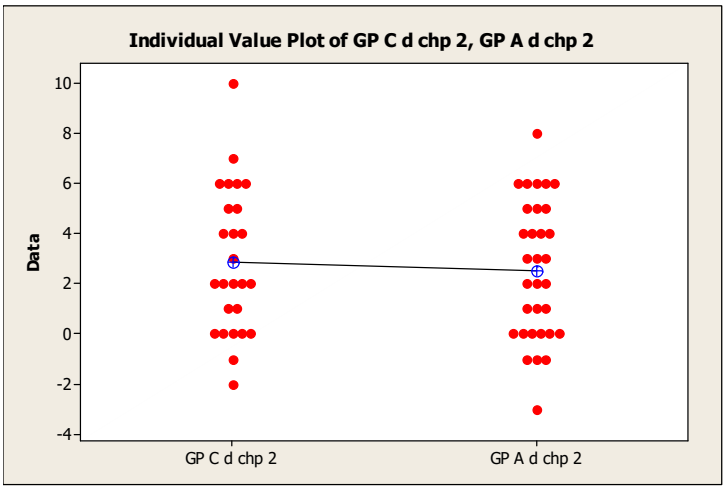


Figure 47. NLY - Two-Sample T-Test and CI: Group C Delta Chapter 2, Group A Delta Chapter 2; Difference = mu (GP C d chp 2) - mu (GP A d chp 2); Estimate for difference: 0.353; 95% lower bound for difference: -0.898; T-Test of difference = 0 (vs >): T-Value = 0.47 P-Value = 0.319 DF = 52.

NESE/ESE

The ratio of students with learning disabilities (ESE) to students without disabilities (NESE) is 36:73 or 32% to 68%. For the ESE division, Group A and Group C each contained 18 students. The NESE division had 38 students in Group A and 35 students in Group C.

Below are the results, at 95% confidence interval, of the entire sample, for students with learning disabilities (ESE) and those without learning disabilities (NESE). Group A was the control group who read from the book. Group C was the experimental group who read from the computer with images.

NESE

These students without learning disabilities show statistically similar performance in both the experimental and control reading formats, for both chapters, in tests one through four. There is also not a statistical difference in performance between the two reading formats in the two-sample t-tests.

NESE	N	Mean	StDev	SE Mean
GP A chp 1 post	38	13.474	4.842	0.785
GP A chp 1 pre	38	10.211	4.167	0.676
Difference	38	3.263	3.622	0.588

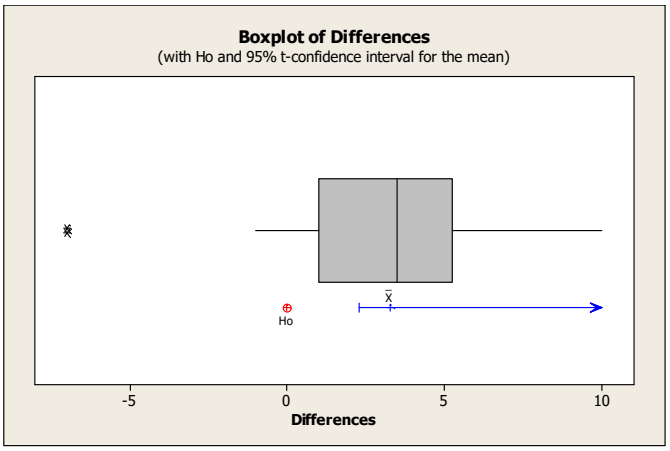


Figure 48. NESE - Paired T-Test and CI: Group A Chapter 1 Post-test, Group A Chapter 1 Pre-test; 95% lower bound for mean difference: 2.272; T-Test of mean difference = 0 (vs > 0): T-Value = 5.55 P-Value = 0.000; r = 0.674.

NESE	N	Mean	StDev	SE Mean
GP A chp 2 post	38	9.158	4.559	0.740
GP A chp 2 pre	38	7.079	4.029	0.654
Difference	38	2.079	2.283	0.370

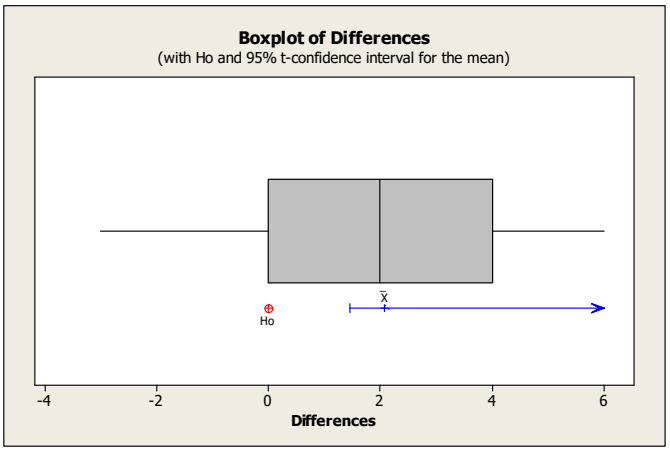


Figure 49. NESE - Paired T-Test and CI: Group A Chapter 2 Post-test, Group A Chapter 2 Pre-test; 95% lower bound for mean difference: 1.454; T-Test of mean difference = 0 (vs > 0): T-Value = 5.61 P-Value = 0.000; r = 0.678.

NESE	N	Mean	StDev	SE Mean
GP C chp 1 post	35	12.229	5.292	0.895
GP C chp 1 pre	35	8.886	4.150	0.701
Difference	35	3.343	2.765	0.467

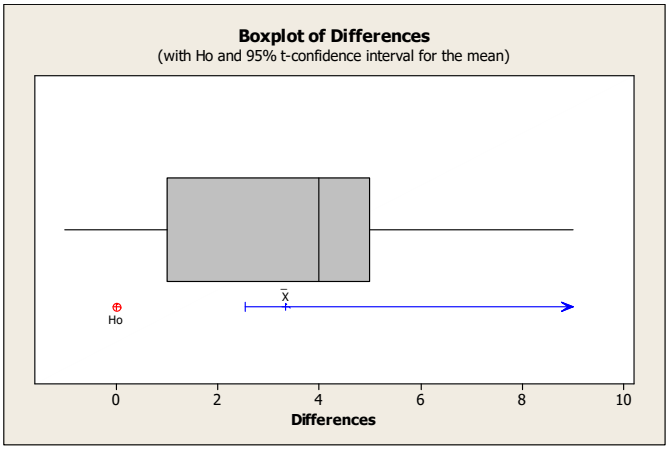


Figure 50. NESE - Paired T-Test and CI: Group C Chapter 1 Post-test, Group C Chapter 1 Pre-test; 95% lower bound for mean difference: 2.553; T-Test of mean difference = 0 (vs > 0): T-Value = 7.15 P-Value = 0.000; r = 0.775.

NESE	N	Mean	StDev	SE Mean
GP C chp 2 post	35	7.486	3.729	0.630
GP C chp 2 pre	35	5.486	3.302	0.558
Difference	35	2.000	2.485	0.420

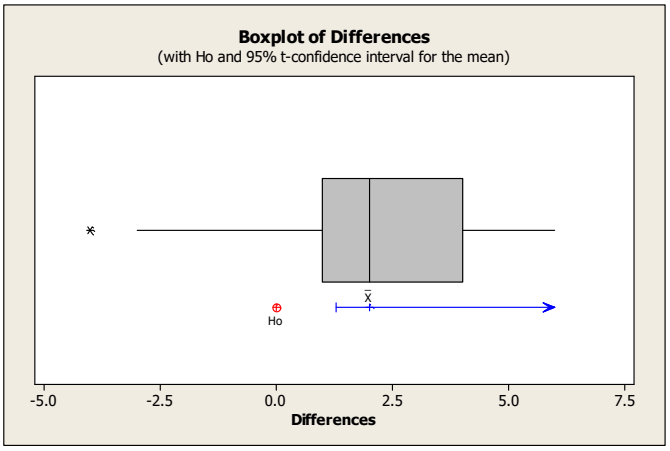


Figure 51. NESE - Paired T-Test and CI: Group C Chapter 2 Post-test, Group C Chapter 2 Pre-test; 95% lower bound for mean difference: 1.290; T-Test of mean difference = 0 (vs > 0): T-Value = 4.76 P-Value = 0.000; r = 0.632.

NESE	N	Mean	StDev	SE Mean
GP C d chp 1	35	3.34	2.76	0.47
GP A d chp 1	38	3.26	3.62	0.59

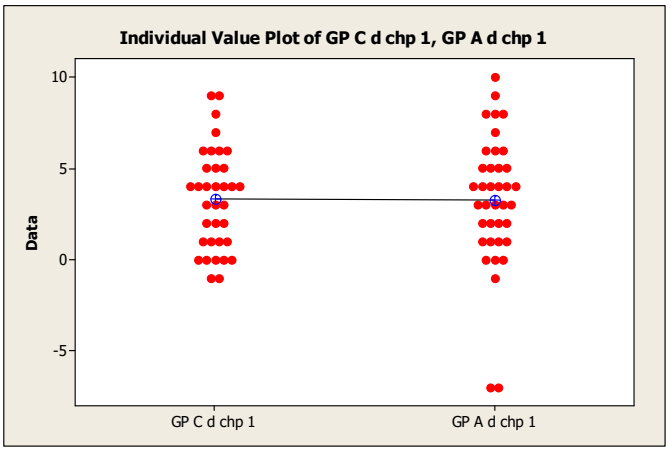


Figure 52. NESE - Two-Sample T-Test and CI: Group C Delta Chapter 1, Group A Delta Chapter 1; Difference = mu (GP C d chp 1) - mu (GP A d chp 1); Estimate for difference: 0.080; 95% lower bound for difference: -1.172; T-Test of difference = 0 (vs >): T-Value = 0.11 P-Value = 0.458 DF = 68.

NESE	N	Mean	StDev	SE Mean
GP C d chp 2	35	2.00	2.49	0.42
GP A d chp 2	38	2.08	2.28	0.37

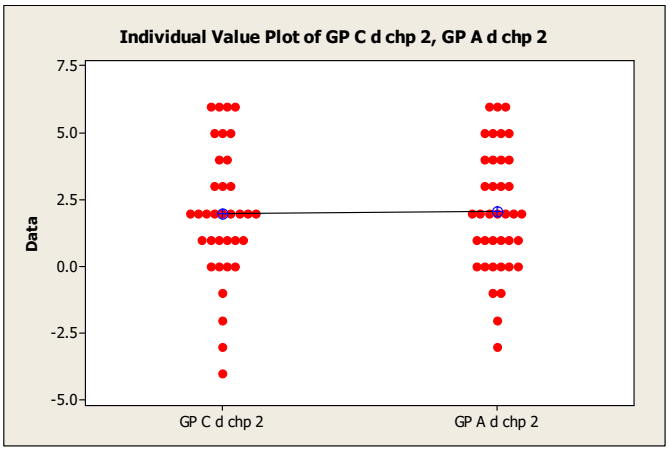


Figure 53. NESE - Two-Sample T-Test and CI: Group C Delta Chapter 2, Group A Delta Chapter 2; Difference = mu (GP C d chp 2) - mu (GP A d chp 2); Estimate for difference: -0.079; 95% lower bound for difference: -1.013; T-Test of difference = 0 (vs >): T-Value = -0.14 P-Value = 0.556 DF = 69.

ESE

In the subgroup of learning disabilities (ESE), the null hypothesis is rejected in all areas, except for the students in the control group (Group A) for Chapter One. This paired t-test gives a p-value of 0.122, well beyond the 0.05 limit. At least for Chapter One, it can be said that the experimental group outperformed the control group for Chapter One. Performance on Chapter Two is statistically similar for both the control and the experimental reading formats. In addition, this subgroup shows a large difference in effect size, such that the experimental group for Chapter One shows an effect size of 0.497 greater than that for the control.

Because of the results in this particular subgroup, further analysis was done to investigate the extent of the impact, and to try to isolate the particular subgroup responsible for the anomaly, should there be one.

ESE	N	Mean	StDev	SE Mean
GP A chp 1 post	18	12.667	3.254	0.767
GP A chp 1 pre	18	11.556	3.634	0.856
Difference	18	1.111	3.909	0.921

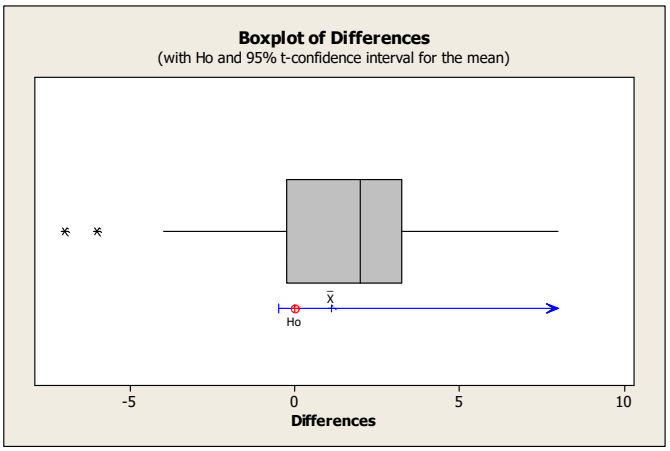


Figure 54. ESE - Paired T-Test and CI: Group A Chapter 1 Post-test, Group A Chapter 1 Pre-test; 95% lower bound for mean difference: -0.492; T-Test of mean difference = 0 (vs > 0): T-Value = 1.21 P-Value = 0.122; r = 0.282.

ESE	N	Mean	StDev	SE Mean
GP A chp 2 post	18	9.500	3.746	0.883
GP A chp 2 pre	18	6.833	3.451	0.813
Difference	18	2.667	2.657	0.626

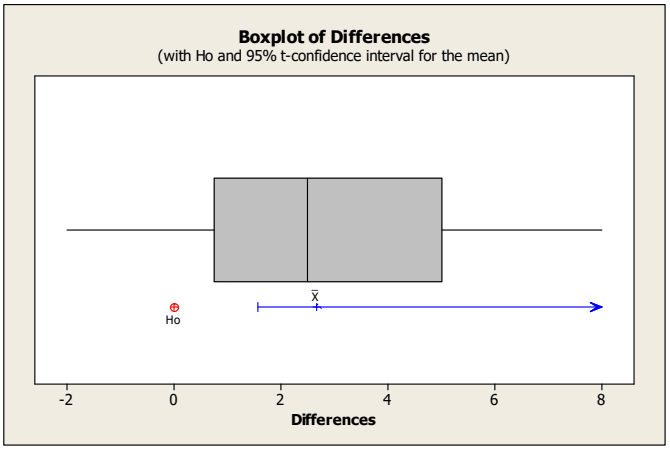


Figure 55. ESE - Paired T-Test and CI: Group A Chapter 2 Post-test, Group A Chapter 2 Pre-test; 95% lower bound for mean difference: 1.577; T-Test of mean difference = 0 (vs > 0): T-Value = 4.26 P-Value = 0.000; r = 0.719.

ESE	N	Mean	StDev	SE Mean
GP C chp 1 post	18	13.44	3.94	0.93
GP C chp 1 pre	18	10.17	4.54	1.07
Difference	18	3.278	2.718	0.641

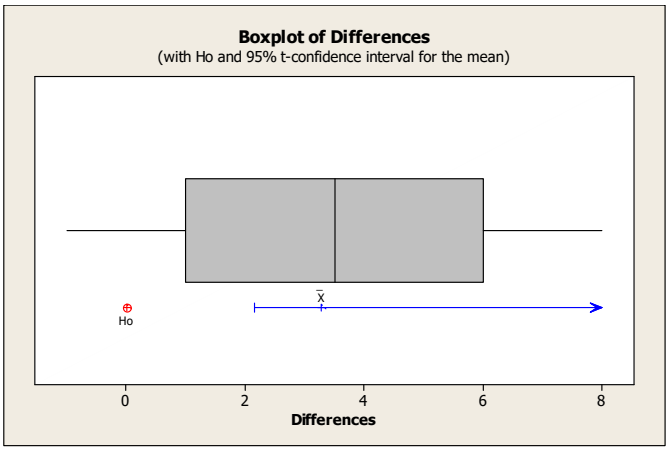


Figure 56. ESE - Paired T-Test and CI: Group C Chapter 1 Post-test, Group C Chapter 1 Pre-test; 95% lower bound for mean difference: 2.163; T-Test of mean difference = 0 (vs > 0): T-Value = 5.12 P-Value = 0.000; r = 0.779.

ESE	N	Mean	StDev	SE Mean
GP C chp 2 post	18	8.667	4.073	0.960
GP C chp 2 pre	18	6.167	2.749	0.648
Difference	18	2.500	3.502	0.825

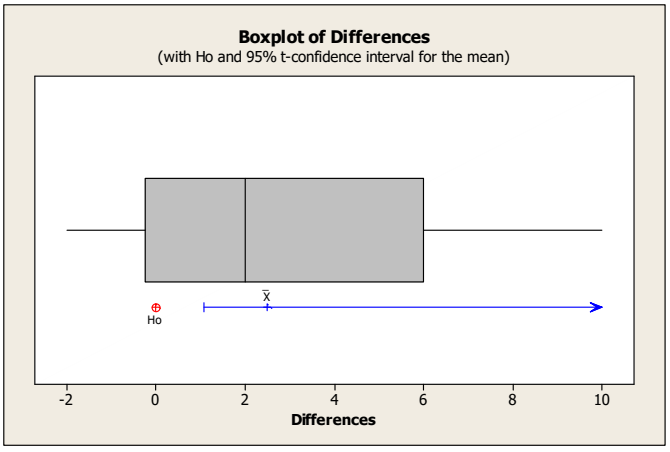


Figure 57. ESE - Paired T-Test and CI: Group C Chapter 2 Post-test, Group C Chapter 2 Pre-test; 95% lower bound for mean difference: 1.064; T-Test of mean difference = 0 (vs > 0): T-Value = 3.03 P-Value = 0.004; r = 0.562.

ESE	N	Mean	StDev	SE Mean
GP C d chp 1	18	3.28	2.72	0.64
GP A d chp 1	18	1.11	3.91	0.92

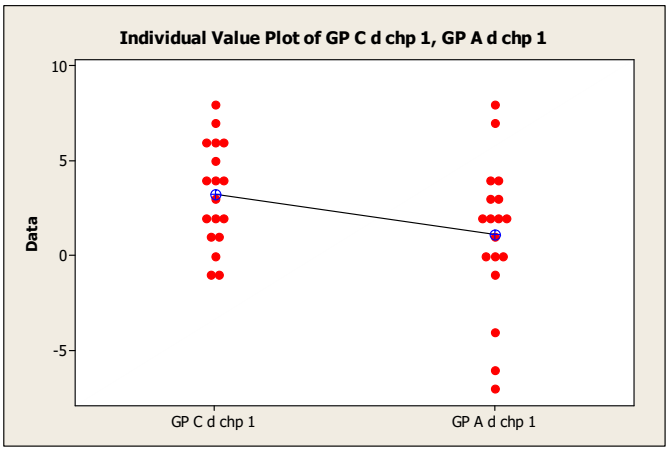


Figure 58. ESE - Two-Sample T-Test and CI: Group C Delta Chapter 1, Group A Delta Chapter 1; Difference = mu (GP C d chp 1) - mu (GP A d chp 1); Estimate for difference: 2.17; 95% lower bound for difference: 0.26; T-Test of difference = 0 (vs >): T-Value = 1.93 P-Value = 0.032 DF = 30.

ESE	N	Mean	StDev	SE Mean
GP C d chp 2	18	2.50	3.50	0.83
GP A d chp 2	18	2.67	2.66	0.63

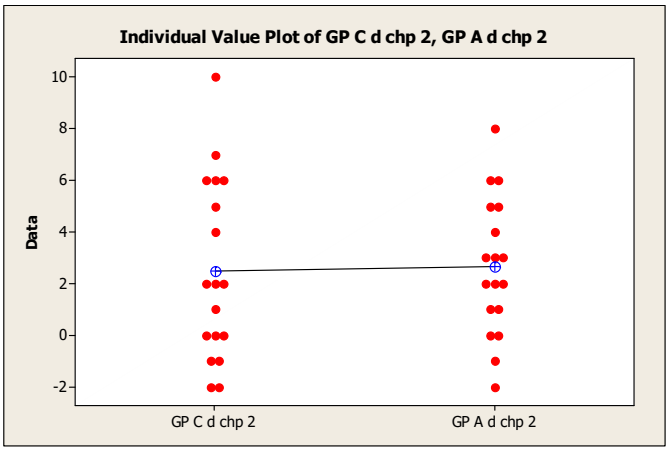


Figure 59. ESE - Two-Sample T-Test and CI: Group C Delta Chapter 2, Group A Delta Chapter 2; Difference = mu (GP C d chp 2) - mu (GP A d chp 2); Estimate for difference: -0.17; 95% lower bound for difference: -1.92; T-Test of difference = 0 (vs >): T-Value = -0.16 P-Value = 0.563 DF = 31.

In order to ascertain the extent of this effect, the subgroups were further segregated into the four possible combinations of language skills and learning disability status. The combinations are proficient/native speakers excluding students with learning disabilities (NLYwNESE), proficient/native speakers including students with learning disabilities (NLYwESE), language learners excluding students with learning disabilities (LYwNESE), language learners including students with learning disabilities (LYwESE). The results of the second level of detailed analysis are below.

Results by Second Level Subgroups

NLYwNESE

Below are the results, at 95% confidence interval, of the subgroup of proficient/native speakers (NLY) who do not have learning disabilities (NESE), by group. This demographic grouping lowers the numbers of subjects to 21 subjects in Group A and 15 subjects in Group C. Group A was the control group who read from the book. Group C was the experimental group who read from the computer with images.

In this grouping where proficient/native speakers who do not have any learning disabilities are separated out, the null hypothesis is rejected. Growth is seen in both groups for both chapters. This result is to be expected from the previous analysis levels where there were no statistical differences for proficient/native speakers, and there were no statistical differences for students without learning disabilities. Statistically, both methods are similar for both chapters for this subgroup combination, however the effect size for the experimental group for Chapter One is one of the largest seen in this study, where $r = 0.842$.

NLYwNESE	N	Mean	StDev	SE Mean
GP A chp 1 post	21	14.43	5.05	1.10
GP A chp 1 pre	21	11.14	4.46	0.97
Difference	21	3.286	3.509	0.766

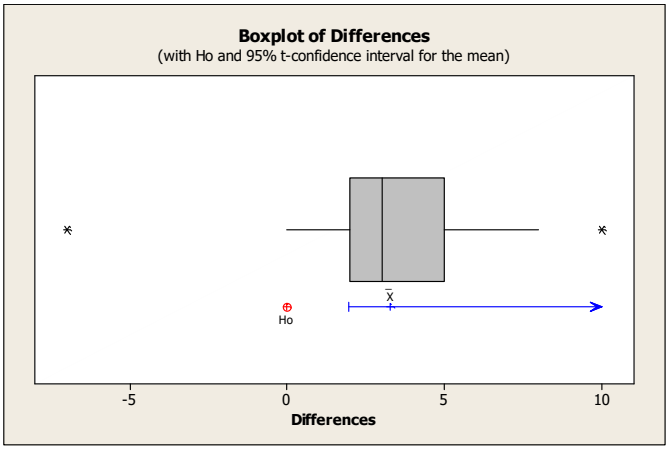


Figure 60. NLYwNESE - Paired T-Test and CI: Group A Chapter 1 Post-test, Group A Chapter 1 Pre-test; 95% lower bound for mean difference: 1.965; T-Test of mean difference = 0 (vs > 0): T-Value = 4.29 P-Value = 0.000; r = 0.692.

NLYwNESE	N	Mean	StDev	SE Mean
GP A chp 2 post	21	11.00	4.75	1.04
GP A chp 2 pre	21	8.90	3.99	0.87
Difference	21	2.095	2.682	0.585

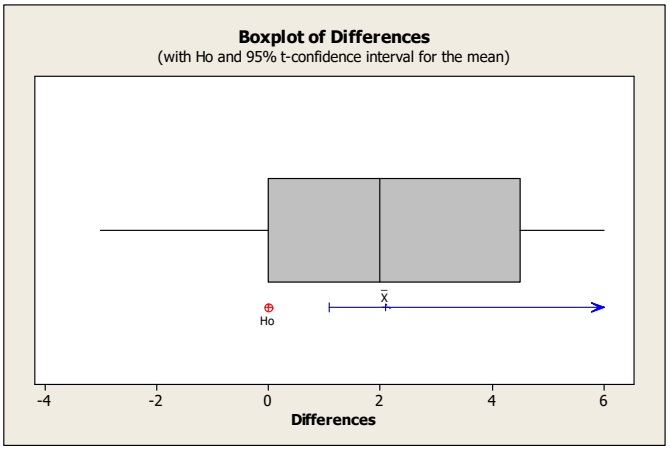


Figure 61. NLYwNESE - Paired T-Test and CI: Group A Chapter 2 Post-test, Group A Chapter 2 Pre-test; 95% lower bound for mean difference: 1.086; T-Test of mean difference = 0 (vs > 0): T-Value = 3.58 P-Value = 0.001; r = 0.625.

NLYwNESE	N	Mean	StDev	SE Mean
GP C chp 1 post	15	14.600	3.334	0.861
GP C chp 1 pre	15	10.667	3.109	0.803
Difference	15	3.933	2.604	0.672

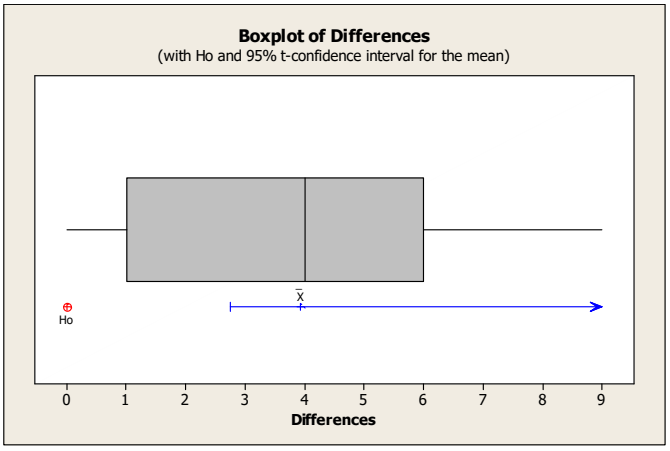


Figure 62. NLYwNESE - Paired T-Test and CI: Group C Chapter 1 Post-test, Group C Chapter 1 Pre-test; 95% lower bound for mean difference: 2.749; T-Test of mean difference = 0 (vs > 0): T-Value = 5.85 P-Value = 0.000; r = 0.842.

NLYwNESE	N	Mean	StDev	SE Mean
GP C chp 2 post	15	9.600	3.158	0.815
GP C chp 2 pre	15	7.467	3.681	0.951
Difference	15	2.133	2.066	0.533

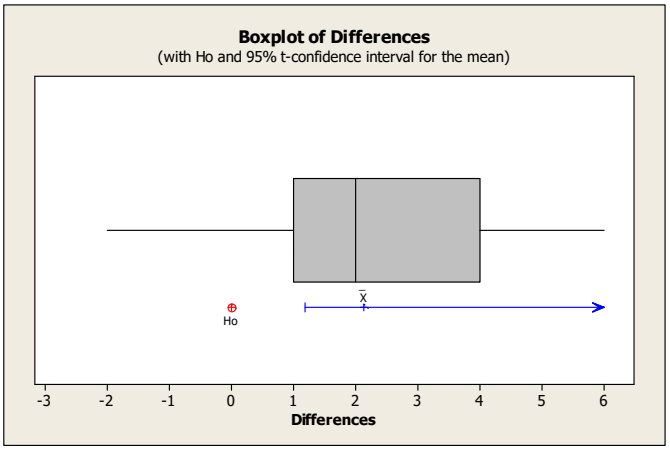


Figure 63. NLYwNESE - Paired T-Test and CI: Group C Chapter 2 Post-test, Group C Chapter 2 Pre-test; 95% lower bound for mean difference: 1.194; T-Test of mean difference = 0 (vs > 0): T-Value = 4.00 P-Value = 0.001; r = 0.730.

NLYwNESE	N	Mean	StDev	SE Mean
GP C d chp 1	15	3.93	2.60	0.67
GP A d chp 1	21	3.29	3.51	0.77

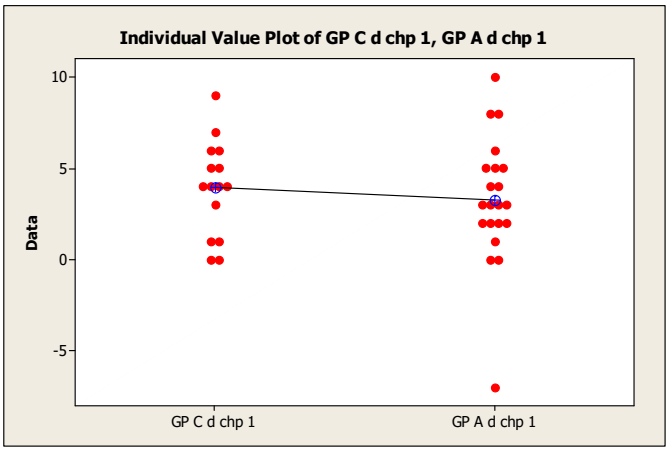


Figure 64. NLYwNESE - Two-Sample T-Test and CI: Group C Delta Chapter 1, Group A Delta Chapter 1; Difference = mu (GP C d chp 1) - mu (GP A d chp 1); Estimate for difference: 0.65; 95% lower bound for difference: -1.08; T-Test of difference = 0 (vs >): T-Value =0.64 P-Value = 0.265 DF =33.

NLYwNESE	N	Mean	StDev	SE Mean
GP C d chp 2	15	2.13	2.07	0.53
GP A d chp 2	21	2.10	2.68	0.59

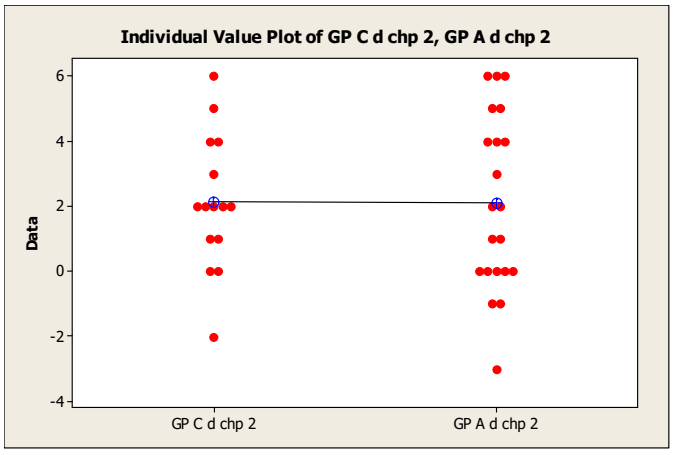


Figure 65. NLYwNESE - Two-Sample T-Test and CI: Group C Delta Chapter 2, Group A Delta Chapter 2; Difference = mu (GP C d chp 2) - mu (GP A d chp 2); Estimate for difference: 0.038; 95% lower bound for difference: -1.573; T-Test of difference = 0 (vs >): T-Value = 0.05 P-Value = 0.962 DF =33.

NLYwESE

Below are the results, at 95% confidence interval, of the subgroup of proficient/native speakers (NLY) who have a learning disability (ESE), by group. Group A was the control group who read from the book. Group C was the experimental group who read from the computer with images.

In the subgroup of native speakers with learning disabilities, the null hypothesis is accepted for the control group for Chapter One. However, the null hypothesis is rejected for the control group for Chapter Two. The null hypothesis is also rejected for the experimental group, which shows vocabulary growth for both chapters. This shows that native English speakers with learning disabilities benefitted from the text with images format, in Chapter One where more explicit vocabulary imagery is used. In this subgroup, the effect size for the experimental version of Chapter One was one of the largest in the study where $r = 0.816$.

NLYwESE	N	Mean	StDev	SE Mean
GP A chp 1 post	11	13.18	3.60	1.09
GP A chp 1 pre	11	11.36	4.23	1.27
Difference	11	1.82	4.29	1.29

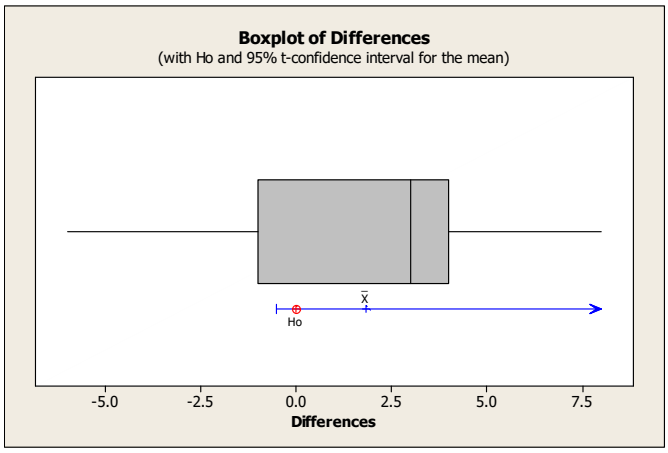


Figure 66. NLYwESE - Paired T-Test and CI: Group A Chapter 1 Post-test, Group A Chapter 1 Pre-test; 95% lower bound for mean difference: -0.52; T-Test of mean difference = 0 (vs > 0): T-Value = 1.41 P-Value = 0.095; r = 0.407.

NLYwESE	N	Mean	StDev	SE Mean
GP A chp 2 post	11	10.55	3.64	1.10
GP A chp 2 pre	11	7.18	2.93	0.88
Difference	11	3.364	2.767	0.834

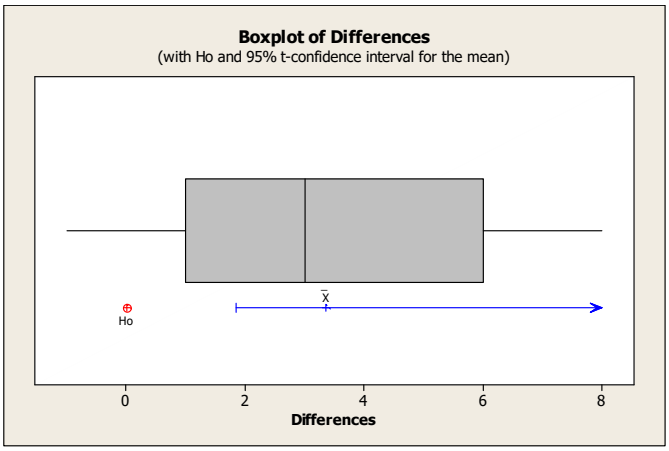


Figure 67. NLYwESE - Paired T-Test and CI: Group A Chapter 2 Post-test, Group A Chapter 2 Pre-test; 95% lower bound for mean difference: 1.852; T-Test of mean difference = 0 (vs > 0): T-Value = 4.03 P-Value = 0.001; r = 0.787.

NLYwESE	N	Mean	StDev	SE Mean
GP C chp 1 post	11	13.73	3.90	1.18
GP C chp 1 pre	11	10.36	3.83	1.15
Difference	11	3.364	2.501	0.754

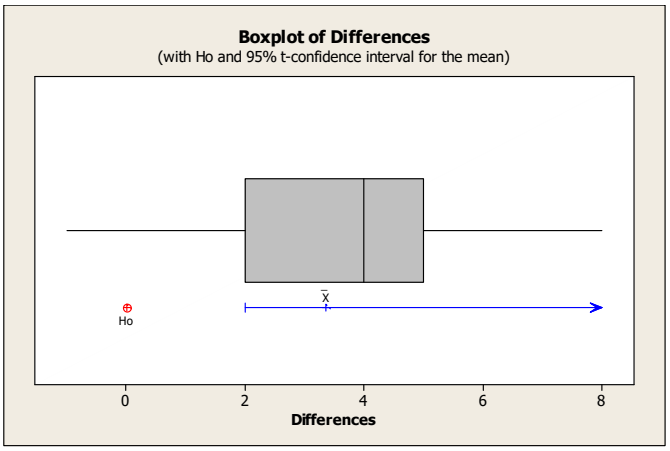


Figure 68. NLYwESE - Paired T-Test and CI: Group C Chapter 1 Post-test, Group C Chapter 1 Pre-test; 95% lower bound for mean difference: 1.997; T-Test of mean difference = 0 (vs > 0): T-Value = 4.46 P-Value = 0.001; r = 0.816.

NLYwESE	N	Mean	StDev	SE Mean
GP C chp 2 post	11	10.45	4.20	1.27
GP C chp 2 pre	11	6.55	3.17	0.96
Difference	11	3.91	3.62	1.09

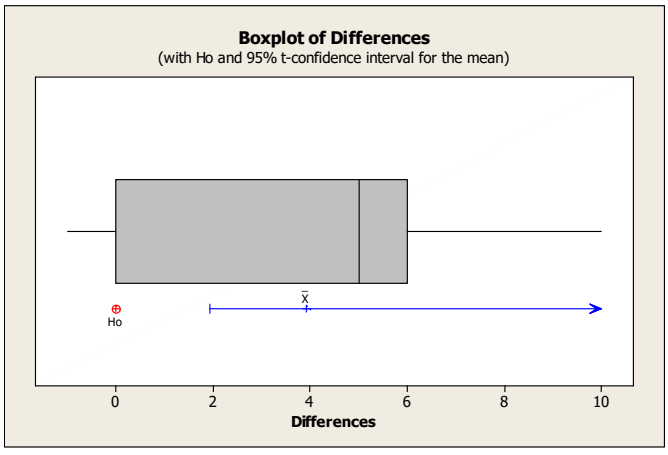


Figure 69. NLYwESE - Paired T-Test and CI: Group C Chapter 2 Post-test, Group C Chapter 2 Pre-test; 95% lower bound for mean difference: 1.93; T-Test of mean difference = 0 (vs > 0): T-Value = 3.58 P-Value = 0.002; r = 0.750.

NLYwESE	N	Mean	StDev	SE Mean
GP C d chp 1	11	3.36	2.50	0.75
GP A d chp 1	11	1.82	4.29	1.3

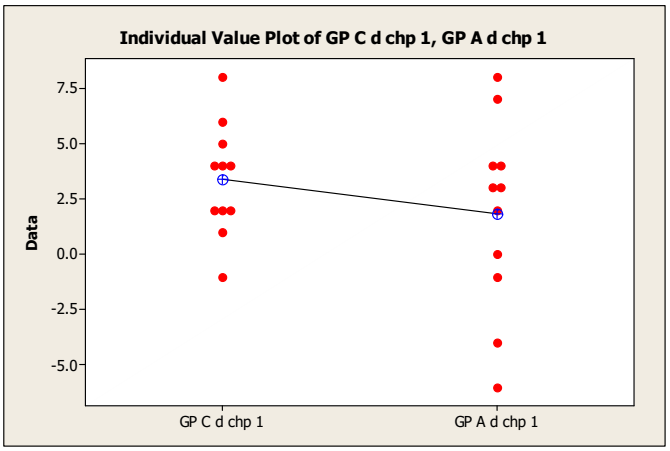


Figure 70. NLYwESE - Two-Sample T-Test and CI: Group C Delta Chapter 1, Group A Delta Chapter 1; Difference = mu (GP C d chp 1) - mu (GP A d chp 1); Estimate for difference: 1.55; 95% lower bound for difference: -1.07; T-Test of difference = 0 (vs >): T-Value = 1.03 P-Value = 0.158 DF = 16.

NLYwESE	N	Mean	StDev	SE Mean
GP C d chp 2	11	3.91	3.62	1.1
GP A d chp 2	11	3.36	2.77	0.83

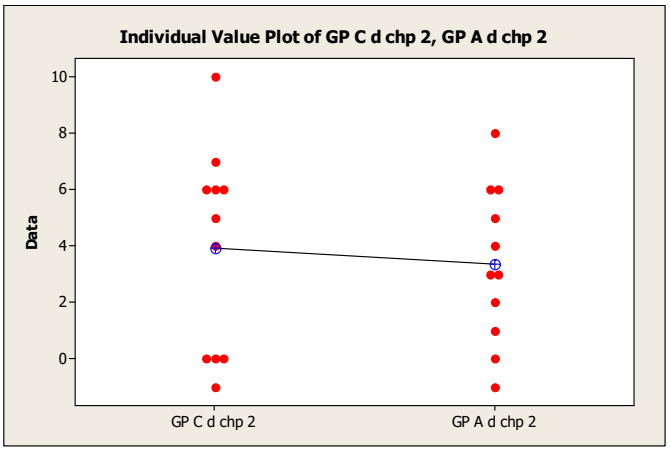


Figure 71. NLYwESE - Two-Sample T-Test and CI: Group C Delta Chapter 2, Group A Delta Chapter 2; Difference = mu (GP C d chp 2) - mu (GP A d chp 2); Estimate for difference: 0.55; 95% lower bound for difference: -1.84; T-Test of difference = 0 (vs >): T-Value = 0.40 P-Value = 0.348 DF = 18.

LYwNESE

Here, Group A has 17 students, while Group C has 20 students. Below are the results, at 95% confidence interval, of the subgroup of language learners (LY) who do not have learning disabilities (NESE). Group A was the control group who read from the book. Group C was the experimental group who read from the computer with images.

As expected from previous data comparing ESE and NESE students, in the category of language learners who do not have learning disabilities, the null hypothesis is rejected by the control and experimental groups for both chapters. Tests one through four show growth in all areas with p-values below 0.05. However, the null hypothesis is accepted in tests five and six (the two-sample t-tests) as there is no statistical difference between the two methods of reading.

LYwNESE	N	Mean	StDev	SE Mean
GP A chp 1 post	17	12.29	4.44	1.08
GP A chp 1 pre	17	9.06	3.56	0.86
Difference	17	3.235	3.865	0.937

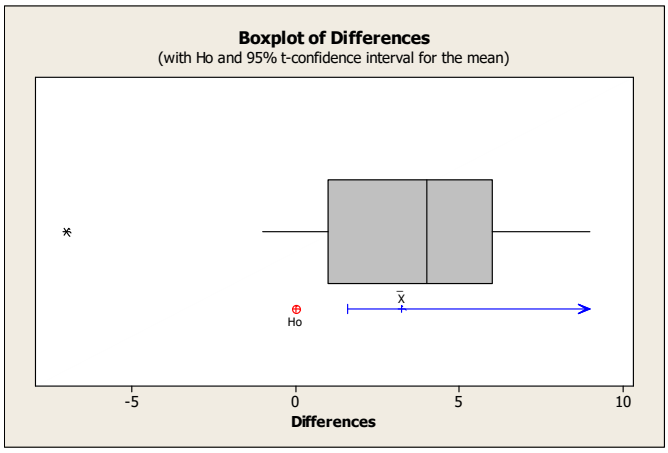


Figure 72. LYwNESE - Paired T-Test and CI: Group A Chapter 1 Post-test, Group A Chapter 1 Pre-test; 95% lower bound for mean difference: 1.599; T-Test of mean difference = 0 (vs > 0): T-Value = 3.45 P-Value = 0.002; r = 0.653.

LYwNESE	N	Mean	StDev	SE Mean
GP A chp 2 post	17	6.882	3.140	0.762
GP A chp 2 pre	17	4.824	2.811	0.682
Difference	17	2.059	1.749	0.424

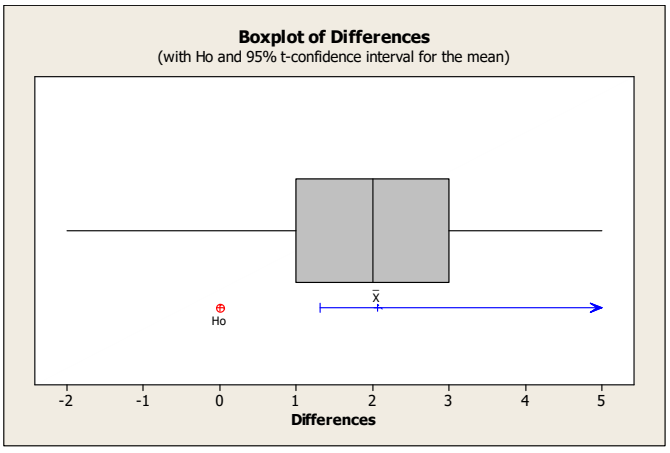


Figure 73. LYwNESE - Paired T-Test and CI: Group A Chapter 2 Post-test, Group A Chapter 2 Pre-test; 95% lower bound for mean difference: 1.318; T-Test of mean difference = 0 (vs > 0): T-Value = 4.85 P-Value = 0.000; r = 0.771.

LYwNESE	N	Mean	StDev	SE Mean
GP C chp 1 post	20	10.45	5.84	1.31
GP C chp 1 pre	20	7.55	4.39	0.98
Difference	20	2.900	2.864	0.640

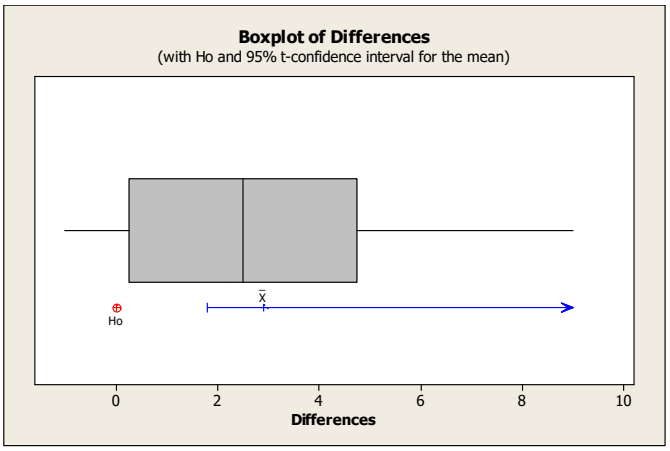


Figure 74. LYwNESE - Paired T-Test and CI: Group C Chapter 1 Post-test, Group C Chapter 1 Pre-test; 95% lower bound for mean difference: 1.793; T-Test of mean difference = 0 (vs > 0): T-Value = 4.53 P-Value = 0.000; r = 0.721.

LYwNESE	N	Mean	StDev	SE Mean
GP C chp 2 post	20	5.900	3.370	0.754
GP C chp 2 pre	20	4.000	2.026	0.453
Difference	20	1.900	2.808	0.628

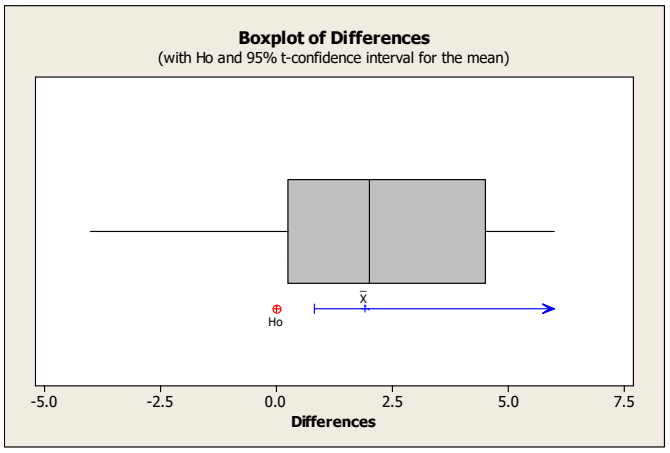


Figure 75. LYwNESE - Paired T-Test and CI: Group C Chapter 2 Post-test, Group C Chapter 2 Pre-test; 95% lower bound for mean difference: 0.814; T-Test of mean difference = 0 (vs > 0): T-Value = 3.03 P-Value = 0.003; r = 0.571.

LYwNESE	N	Mean	StDev	SE Mean
GP C d chp 1	20	2.90	2.86	0.64
GP A d chp 1	17	3.24	3.87	0.94

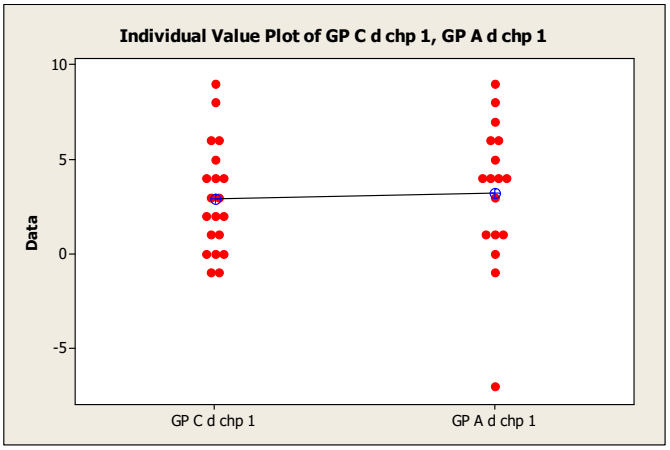


Figure 76. LYwNESE - Two-Sample T-Test and CI: Group C Delta Chapter 1, Group A Delta Chapter 1; Difference = mu (GP C d chp 1) - mu (GP A d chp 1); Estimate for difference: -0.34; 95% lower bound for difference: -2.26; T-Test of difference = 0 (vs >): T-Value = -0.30 P-Value = 0.615 DF = 29.

LYwNESE	N	Mean	StDev	SE Mean
GP C d chp 2	20	1.90	2.81	0.63
GP A d chp 2	17	2.06	1.75	0.42

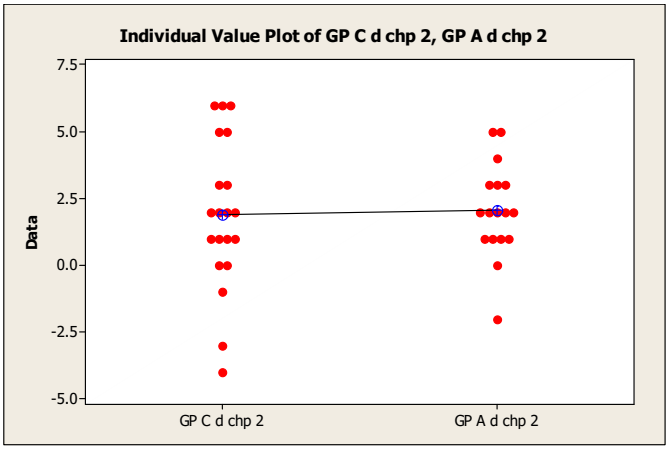


Figure 77. . LYwNESE - Two-Sample T-Test and CI: Group C Delta Chapter 2, Group A Delta Chapter 2; Difference = mu (GP C d chp 2) - mu (GP A d chp 2); Estimate for difference: -0.159; 95% lower bound for difference: -1.442; T-Test of difference = 0 (vs >): T-Value = -0.21 P-Value = 0.582 DF = 32.

LYwESE

Below are the results, at 95% confidence interval, of the subgroup of language learners (LY) who have learning disabilities (ESE). Group A was the control group who read from the book. Group C was the experimental group who read from the computer with images.

This grouping combines the students who are most highly disadvantaged—those who are language learners as well as having learning disabilities. Only for the experimental version of Chapter One is the null hypothesis rejected. The null hypothesis is accepted for the control group (Group A) for both chapters and for the experimental group (Group C) for Chapter Two. This group performed very poorly in the text-only version of Chapter One. However, the effect size seen for the experimental version of Chapter One is comparable to the other groups. The difference in the effect size, therefore, for the performance on Chapter One shows the experimental version to have an effect size of 0.724 larger than the control group.

LYwESE	N	Mean	StDev	SE Mean
GP A chp 1 post	7	11.86	2.67	1.01
GP A chp 1 pre	7	11.86	2.73	1.03
Difference	7	-0.00	3.21	1.21

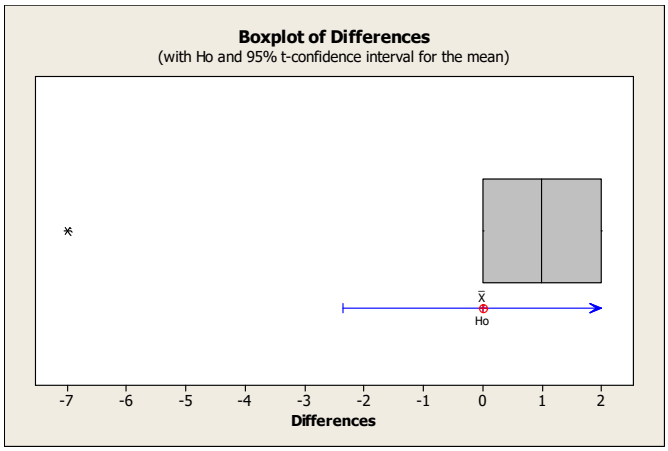


Figure 78. . LYwESE - Paired T-Test and CI: Group A Chapter 1 Post-test, Group A Chapter 1 Pre-test; 95% lower bound for mean difference: -2.36; T-Test of mean difference = 0 (vs > 0): T-Value = -0.00 P-Value = 0.500; r = 0.0.

LYwESE	N	Mean	StDev	SE Mean
GP A chp 2 post	7	7.86	3.53	1.34
GP A chp 2 pre	7	6.29	4.35	1.64
Difference	7	1.571	2.225	0.841

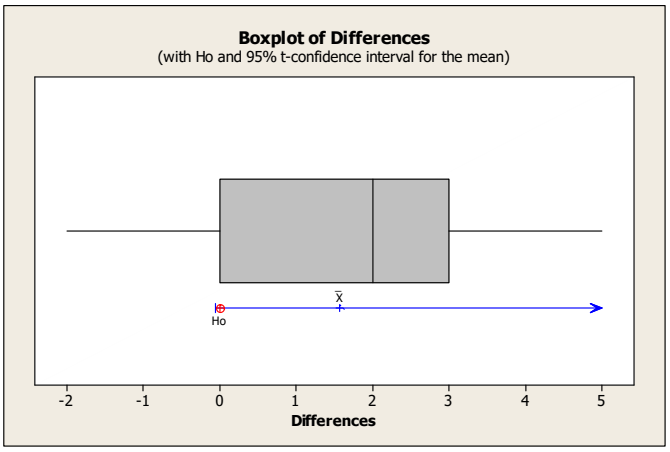


Figure 79. LYwESE - Paired T-Test and CI: Group A Chapter 2 Post-test, Group A Chapter 2 Pre-test; 95% lower bound for mean difference: -0.063; T-Test of mean difference = 0 (vs > 0): T-Value = 1.87 P-Value = 0.055; r = 0.607.

LYwESE	N	Mean	StDev	SE Mean
GP C chp 1 post	7	13.00	4.28	1.62
GP C chp 1 pre	7	9.86	5.81	2.20
Difference	7	3.14	3.24	1.22

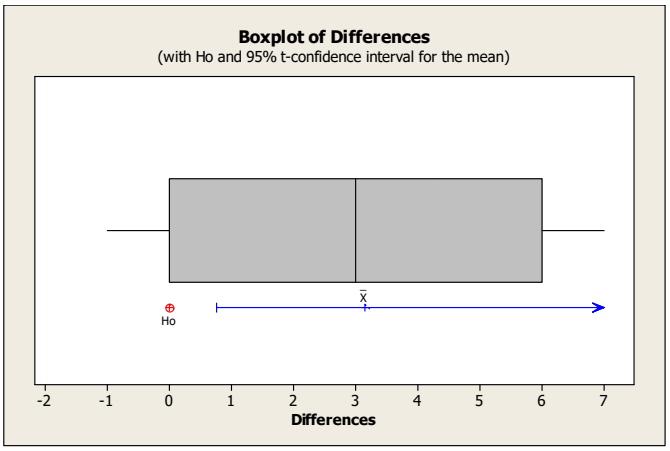


Figure 80. LYwESE - Paired T-Test and CI: Group C Chapter 1 Post-test, Group C Chapter 1 Pre-test; 95% lower bound for mean difference: 0.77; T-Test of mean difference = 0 (vs > 0): T-Value = 2.57 P-Value = 0.021; r = 0.724.

LYwESE	N	Mean	StDev	SE Mean
GP C chp 2 post	7	5.857	1.574	0.595
GP C chp 2 pre	7	5.571	1.988	0.751
Difference	7	0.286	1.890	0.714

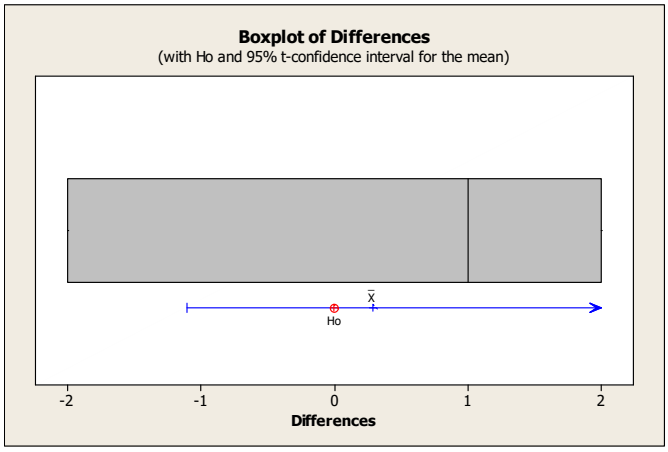


Figure 81. LYwESE - Paired T-Test and CI: Group C Chapter 2 Post-test, Group C Chapter 2 Pre-test; 95% lower bound for mean difference: -1.102; T-Test of mean difference = 0 (vs > 0): T-Value = 0.40 P-Value = 0.352; r = 0.161.

LYwESE	N	Mean	StDev	SE Mean
GP C d chp 1	7	3.14	3.24	1.2
GP A d chp 1	7	0.29	3.50	1.3

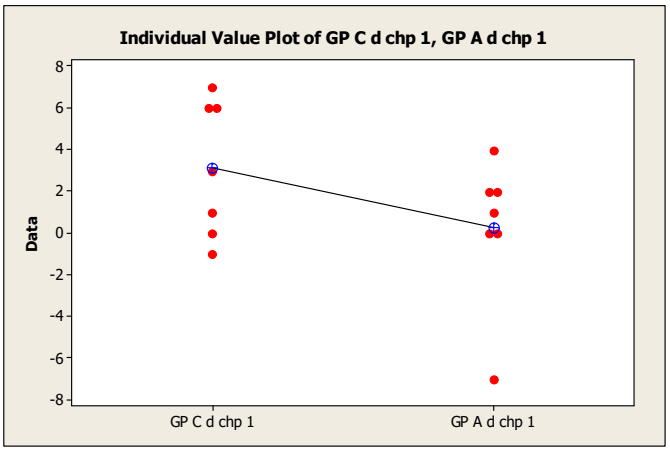


Figure 82. LYwESE - Two-Sample T-Test and CI: Group C Delta Chapter 1, Group A Delta Chapter 1; Difference = mu (GP C d chp 1) - mu (GP A d chp 1); Estimate for difference: 2.86; 95% lower bound for difference: -0.38; T-Test of difference = 0 (vs >): T-Value = 1.59 P-Value = 0.071 DF = 11.

LYwESE	N	Mean	StDev	SE Mean
GP C d chp 2	7	0.29	1.89	0.71
GP A d chp 2	7	1.57	2.23	0.84

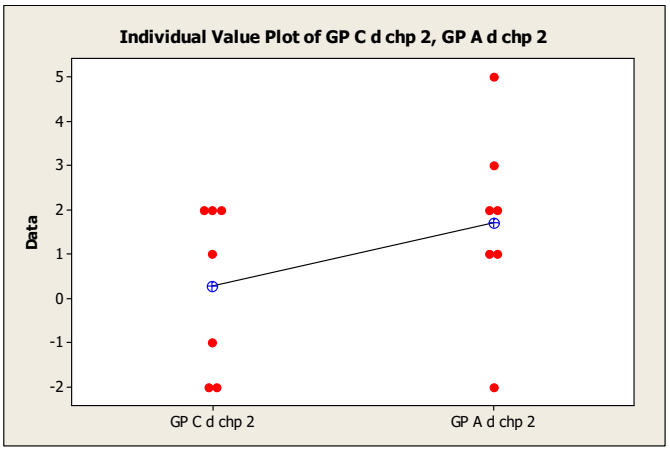


Figure 83. LYwESE - Two-Sample T-Test and CI: Group C Delta Chapter 2, Group A Delta Chapter 2; Difference = mu (GP C d chp 2) - mu (GP A d chp 2); Estimate for difference: -1.29; 95% lower bound for difference: -3.27; T-Test of difference = 0 (vs >): T-Value = -1.17 P-Value = 0.866 DF = 11.

This is the smallest set of study subjects. Here, each group has only seven students. However, the statistical indifference to the control method (Group A) implies that these students need something additional in order to make gains in their vocabulary. Reading the text alone is not sufficient to produce gains. The experimental method of text with images (Group C) shows more promise. For the experimental method, Chapter Two has only four of the ten words explicitly depicted, and the null hypothesis is accepted. However, Chapter One has nine of the ten vocabulary words explicitly shown in images, and demonstrates positive vocabulary growth. Due to the limited sample of this particular subset of students, conclusions cannot be drawn with statistical certainty, but the implication of the effect is clear.

It is relevant to note that the experimental group managed to show vocabulary growth in the chapter where visual representations of the words were explicit. This seems to reinforce Paivio's assertion that mediating thought processes for verbal exchanges are not necessarily verbally structured (Paivio 241-42). Also, since it was allowed for language learners to answer in their native language of Spanish, it is possible to apply Vygotsky's notion that meaning is not equal to the word or equal to the thought, but lies between (80). The images were able to convey meaning in a representational format, and these students were able to express their knowledge of the word or story meaning in their native language.

Overview of Results

After careful and rigorous analysis, it can be said that for those students with learning disabilities (ESE), the experimental reading method holds promise, especially for language learners with learning disabilities (LYwESE). This is the most important finding in this study. Although all the students were categorized by their reading level as similar, the specific language

and learning abilities and disabilities of these students means that, below the superficial label of reading level, this was a very non-homogenous group. By evaluating the results in each of these various categories, the anomalies were revealed and further investigated.

Only for the language learners with learning disabilities (LYwESE) for the text-only version of Chapter One was there no effect. Data for all other categories shows that reading either the text-only version, or the text-with-images version has a large effect. For all types of students who do not have learning disabilities the experimental treatment of text with images read from a computer screen is statistically similar to the control of reading the text from the book. The table below summarizes all the analyses performed, by demographic divisions. The control group was Group A. The experimental reading method was used by Group C. Discussion of how these results fit within the current body of knowledge in this area will be the topic of Chapter 5, Summary and Conclusions.

Table 4. This table contains a summary of all the data groups, test descriptions, p-values, and the effect size

Analysis Group	**Test Description**	**P-Value**	**Effect Size *r***
All	Grp A, Chp 1	0.000	0.562
	Grp A, Chp 2	0.000	0.69
	Grp C, Chp 1	0.000	0.776
	Grp C, Chp 2	0.000	0.61
	Grp A vs. Grp C, Chp 1	0.120	0.112
	Grp A vs. Grp C, Chp 2	0.577	-0.019
Females	Grp A, Chp 1	0.001	0.601
	Grp A, Chp 2	0.001	0.634
	Grp C, Chp 1	0.000	0.819
	Grp C, Chp 2	0.001	0.621
	Grp A vs. Grp C, Chp 1	0.440	0.023
	Grp A vs. Grp C, Chp 2	0.364	0.053

Males	Grp A, Chp 1	0.000	0.536
	Grp A, Chp 2	0.000	0.725
	Grp C, Chp 1	0.000	0.755
	Grp C, Chp 2	0.000	0.604
	Grp A vs. Grp C, Chp 1	0.082	0.168
	Grp A vs. Grp C, Chp 2	0.712	-0.068
LY	Grp A, Chp 1	0.004	0.514
Language Learners	Grp A, Chp 2	0.000	0.724
	Grp C, Chp 1	0.000	0.721
	Grp C, Chp 2	0.004	0.493
	Grp A vs. Grp C, Chp 1	0.248	0.097
	Grp A vs. Grp C, Chp 2	0.751	-0.095
NLY	Grp A, Chp 1	0.000	0.598
Proficient/Native Speakers	Grp A, Chp 2	0.000	0.685
	Grp C, Chp 1	0.000	0.83
	Grp C, Chp 2	0.000	0.712
	Grp A vs. Grp C, Chp 1	0.140	0.14
	Grp A vs. Grp C, Chp 2	0.319	0.062
ESE	Grp A, Chp 1	0.122	0.282
Learning Disability	Grp A, Chp 2	0.000	0.719
	Grp C, Chp 1	0.000	0.779
	Grp C, Chp 2	0.004	0.562
	Grp A vs. Grp C, Chp 1	0.032	0.307
	Grp A vs. Grp C, Chp 2	0.563	-0.027
NESE	Grp A, Chp 1	0.000	0.674
No Learning Disability	Grp A, Chp 2	0.000	0.678
	Grp C, Chp 1	0.000	0.775
	Grp C, Chp 2	0.000	0.632
	Grp A vs. Grp C, Chp 1	0.458	0.012
	Grp A vs. Grp C, Chp 2	0.556	-0.017
NLYwNESE	Grp A, Chp 1	0.000	0.692
Proficient/Native Speakers	Grp A, Chp 2	0.001	0.625
Without Learning Disabilities	Grp C, Chp 1	0.000	0.842
	Grp C, Chp 2	0.001	0.73
	Grp A vs. Grp C, Chp 1	0.265	0.103
	Grp A vs. Grp C, Chp 2	0.962	0.006
NLYwESE	Grp A, Chp 1	0.095	0.407
Proficient/Native Speakers	Grp A, Chp 2	0.001	0.787
With Learning Disabilities	Grp C, Chp 1	0.001	0.816
	Grp C, Chp 2	0.002	0.75
	Grp A vs. Grp C, Chp 1	0.158	0.214
	Grp A vs. Grp C, Chp 2	0.348	0.085

LYwNESE	Grp A, Chp 1	0.002	0.653
Language Learners	Grp A, Chp 2	0.000	0.771
Without Learning Disabilities	Grp C, Chp 1	0.000	0.721
	Grp C, Chp 2	0.003	0.571
	Grp A vs. Grp C, Chp 1	0.615	-0.05
	Grp A vs. Grp C, Chp 2	0.582	-0.034
LYwESE	Grp A, Chp 1	0.500	0
Language Learners	Grp A, Chp 2	0.055	0.607
With Learning Disabilities	Grp C, Chp 1	0.021	0.724
	Grp C, Chp 2	0.352	0.161
	Grp A vs. Grp C, Chp 1	0.071	0.389
	Grp A vs. Grp C, Chp 2	0.866	-0.296

CHAPTER 5 – SUMMARY AND CONCLUSIONS

As stated at the end of Chapter 1 of this dissertation, the value of this research hinges on the idea that exchanging illustrations for descriptive text can provide appropriate schemas for students with reading difficulties and thereby improve their comprehension. The research hypothesis, stated simply, said that the students' post-test scores would be higher than their pre-test scores, when looked at by group and separated by chapter. The control group was denoted as Group A, and the experimental group was denoted as Group C. The reading selection covered two chapters. This could be written in the form, where μ→mean, for each chapter, for each group:

$$H_a : \mu_{pre} < \mu_{post}$$

Since tests five and six were two-sample t-tests, the equation could be described such that for each group, for each chapter where $\mu \rightarrow average$

$$H_0 : \mu_{\Delta GroupC} = \mu_{\Delta GroupA}$$
$$H_a : \mu_{\Delta GroupA} < \mu_{\Delta GroupC}$$

The hypothesis for this study was only partly affirmed but showed statistical significance in the specific subcategories of students with learning disabilities, and particularly for English language learners with disabilities. Below, the key theories that form the foundation of this investigation

are reviewed in order to understand the results of this study through the lens of previous research.

Summary

There is strong consensus that images support comprehension, particularly for students who are adequate decoders but have comprehension problems (Levin 19; Pressley 610-12; Mayer and Sims 391; Cain 178). Content knowledge has been shown to aid in comprehension, but the work involved in processing unfamiliar words or terminology can tire a "poor" reader (Stothard and Hulme 98). The theory behind this current study is that presenting schema "templates" or "building blocks" in the form of images, along with text, would lighten the cognitive load and facilitate the modification of schemas, the acquisition of vocabulary, and speed of the learning process with the goal of helping students attain their expected performance level.

The foundation of this research study comes from the fields of Psychology, Education, and Reading. Paivio and Vygotsky both postulated that a mediating process exists between the verbal or textual input of information and the verbal or textual output of a response (Paivio 241-42; Vygotsky 80). It has been suggested that this mediating process is an internal structure relating more to the impressions and connotations than to the letters or sounds of a word (Vygotsky 80). Although the exchange of information might occur verbally, the cognition process and computation of meaning may occur in a non-verbal format (Hancock 137; Paivio 241-42).

Paivio and his colleagues conducted experiments that demonstrated that imagery was a viable learning tool (254). They conjectured that imagery is a parallel processing system, alongside the verbal system (Paivio 257). The Schnotz and Bannert model of information processing also supports the concept of imagery and verbal as parallel processing systems and is used to argue that informational equivalence does not necessarily mean equal computational efficiency (145, 148). Their model proposed that conceptual crossover exists between non-tangible concepts (e.g., truth, justice) and mental spatial constructions (e.g., the physical setting of a story) regardless of whether the information was obtained verbally or visually (Schnotz and Bannert 145).

Another way of looking at images is as a method of recoding information. Recoding is a skill that allows informational units to be remembered in conceptual or meaningful form and would apply to the use of images, rather than individual words, to hold more information per unit. Miller expanded on his idea of a limited short-term memory of approximately seven items with the idea of recoding (94). Thus, for students who have difficulty processing language, the image of an event or location can act as a single container for a large amount of data, rather than a collection of words that have to be processed and used to create the mental image of the same event or location (Kenny and Gunter 42).

The purpose of narrative is to transfer the mental construct of a place, characters, and events from the author to reader (Bal 5, 36; Pinker 66). Bower and Morrow suggest that this includes a mental map of the physical settings, impressions of character traits and relationships, and visualizations of characters (44). It has been shown by a variety of studies that comprehension and learning can be better achieved by using an appropriate combination of images and text. Salomon states that the symbol systems used by particular mediums (including

images and technology) interact with the comprehension process (19). Verbal or textual communication allows conditional states to be made known (i.e., might, possibly), but the use of images in the formation of meaning is important to understanding (Salomon 70).

Conclusions

The results of this study have shown that using images in the text is statistically equivalent to reading text-only for the majority of students. However, for those students for whom reading is particularly difficult, the addition of the images is the difference between an increase in learning and no learning. In the end, this study demonstrated that the model using images with text allowed those students who were most disadvantaged to make positive gains, when the control group who were reading only text failed to show improvement. In particular, students in this study who have any type of learning disability showed statistically higher learning gains with the experimental model. However, the most notable effect can be seen in the students who are language learners who have any type of learning disability. This particular subgroup only made gains using the experimental model of reading.

The lack of homogeneity in today's classrooms adds to the difficulty in isolating key components of valuable teaching methods. In this study, the original group had to be subdivided into narrow demographic groups in order to isolate the students who benefited from this method. Looking at the larger set of subjects, the gains were not apparent. Looking at the larger division of the control versus the experimental groups, the percentages of students affected by the reading method were not high enough to show statistical significance. Only when the findings were analyzed at the first level of subgroups was the inconsistency in learning made visible. The first

inconsistency appeared in the division between students with learning disabilities and students without. Then, by further subdividing those categories, the image came into clearer focus. For the students with learning disabilities, native and proficient English speakers showed indifferent results for the text-only version of Chapter One but showed gains in the experimental version of Chapter One. However, the English language learners who have learning disabilities were the students for whom the text-only version failed in both chapters and for whom the text with images style of reading is most beneficial.

We can conjecture that it is the explicit inclusion of the vocabulary words in the images that differentiates the positive results for Chapter One from the indifferent results for Chapter Two. In Chapter One, ten of the ten vocabulary words are illustrated in the images that are included. In Chapter Two, however, only four of the ten vocabulary words are explicitly portrayed. The images in Chapter Two were oriented more toward the setting and physical context of the story. This conclusion cannot be statistically supported due to the small numbers of students in the subdivision of English language learners with disabilities, but the inferential evidence points in this direction.

Returning to the cognitive processing model of Mayer and the model of Schnotz and Bannert, it seems that the latter provides a better presentation of what appears to have taken place in this study. In particular, Schnotz and Bannert's assertion that informational equivalence (descriptive text that details a visual image or vice versa) does not equal computational efficiency, is clearly visible in the results of the students with learning disabilities (148). While most students managed to pull meaning from both versions of the text, the students with learning disabilities definitely received the most advantage from the visual presentation. With the explicit visual presentation of the vocabulary words in the experimental model of Chapter One, learning

disabled students had better success than with the visual presentation of supplemental and contextual information in the majority of the images in the experimental version of Chapter Two. This implies that it is not only the lessening of the cognitive load that aided their success, but that the visual images of the vocabulary words were informationally superior to the textual presentation of the vocabulary words for those students (Salomon 66, 70, 72). This would also support Vygotsky's "zone of proximal development" and Kintsch's "zone of proximal learning" where the images function as a form of assistance to move the students to perform beyond the bounds of their independent ability (Vygotsky 187, Kintsch 323).

In this same vein, it may be useful to carefully study the effects of illustrations in children's books on reading comprehension. Since research has shown that visuals are far more effective when they are accurate representations of the text (Pressley 586, 613, 615), the evaluation of the use of artwork and illustrations in children's stories, from picture books to illustrated chapter books, may provide another means to support early reading and comprehension skill building. Rather than simply using an artist's interpretation, consideration as to whether the image contradicts any other part of the story structure, or in some other way impacts cognitive load, might strengthen the medium of children's books and their role in cognitive development, reading skills, and comprehension.

Schema building, which was heavily discussed earlier in this work, seems to take more time than was available in this study. As Miller noted in his study regarding re-coding, the capability to effectively re-code information has to reach a level of automaticity before it can impact cognitive load (94). With only two chapters in the study, the building and use of schemas appropriate to this story did not have time to sufficiently develop in order to have a notable impact on the students' learning. Future studies should consider a longer reading selection,

spread across a generous timeframe in order to make the most of the developmental process of schema building. As noted by Tracey and Morrow, there are three processes for altering schemas: 1) accretion, where new information is added to an existing schema, 2) tuning, where new information forces the modification of an existing schema, and 3) restructuring, where an existing schema is no longer sufficient or cannot be modified, and a new schema must be created (52). It would be interesting to see a study that established a baseline of existing schemas, then used a modification of this study to expand those schemas and tested the extent of their development in comparison to learning gains or reading ability changes.

In the particular school district where this study was conducted, the trend today is toward inclusion in education. The inclusion model limits classes designed to segregate students with particular disabilities into separate classes with modified curriculum. There will still be regular and advanced courses, but fewer "pull-out" classes of small size with modified curriculum for these students. It is difficult to understand how teachers will be able to meet the learning needs of students, all in a single classroom, from a variety of skill levels, language abilities, reading abilities, and learning disabilities. This study shows that these students, all of whom are grouped together based on their reading scores (and thus are one of the more homogeneous groups today), have a variety of learning needs. With the move toward mainstream inclusion, students will have fewer opportunities to be separated into classes designed to work with disabilities or to remediate specific skills.

This research study shows promise as a method of teaching in a classroom containing all varieties of learners. This method of reading has been shown to be at least equal to reading text-only for the majority of students who are classified as low-level readers. However, for those students who need something additional, this format shows promise as the only method that

demonstrated positive learning gains. At the very least, this format for reading will not do any disservice to the average student reading well below grade-level, but may be the lifeline that the students with learning disabilities need to help them succeed.

Future research in this area should consider the impact of color images, and video supplements for text, as an alternative to black and white images. It is possible that, in this generation with more life-like video games, the black and white format is not sufficient to hold the students' attention. Studies that consider gender, particularly with regard to the difference in learning preferences for various graphic supplements, might also bring out learning preferences previously overlooked. It was noted in earlier works that one reason girls develop linguistically ahead of boys was the verbal interaction they receive very early in their development, along with rhyming games, et cetera. With these types of activities often taking a backseat to longer school hours or more indoor and electronic activities, it is possible there could be a backward trend where more girls show underdeveloped phonetic skills, while boys who are engaged in narrative style video games may show an increase in comprehension skills. Future work in this field may want to consider such trends in evaluating the performance of students with regard to reading trends. The variety of media in use by students today and the impact of the use of that media are also of interest with regard to the impact on reading skills and cognitive modeling. This study demonstrated the impact of the use of media with a particular demographic of low-level readers, but there is still much work to be done in the field of reading skills and the cognitive processing involved in reading.

APPENDIX A: CHAPTER ONE PRE-TEST

Chapter 1 Vocabulary Test (pre)

Cowbell

Oxen

Forest

Cart / Oxcart

The Border

Cartwheel

Rice seed

Temple

Village

Gunnysack

APPENDIX B: CHAPTER 2 PRE-TEST

Chapter 2 Vocabulary Test (pre)

Converging

Twig

Kindling

Refugee camp

Well / well water

Beam / crossbeam

Sarong

Dipper / ladle

Mat / sleeping mat

Barren

APPENDIX C: CHAPTER ONE POST-TEST

Chapter 1 Vocabulary Test (post)

The Border

Oxen

Rice seed

Cart / Oxcart

Cowbell

Cartwheel

Forest

Gunnysack

Village

Temple

APPENDIX D: CHAPTER TWO POST-TEST

Chapter 2 Vocabulary Test (post)

Refugee camp

Twig

Beam / crossbeam

Converging

Well / well water

Kindling

Barren

Dipper / ladle

Mat / sleeping mat

Sarong

APPENDIX E: COMPREHENSION QUESTIONS

Comprehension Questions

Why are Dara and her family traveling?

Who is traveling with Dara and where are the other members of her family?

Where are they going?

What do they hope to find?

How do they feel when they arrive?

APPENDIX F: STUDENT SCORES

Chapter One Test Scores
Raw Data

grade	gender	ethnicity	LY		ESE	Group	cowbell 1	oxen 1	forest 1	cart / oxcart 1	the border 1	cartwheel 1	rice seed 1	temple 1	village 1	gunnysack 1	**sum chp 1 pre**	the border 2	oxen 2	rice seed 2	cart / oxcart 2	cowbell 2	cartwheel 2	forest 2	gunnysack 2	village 2	temple 2	**sum chp 1 post**
8	M	B	LY			A	0	0	2	0	0	0	1	2	2	0	**7**	2	0	1	0	2	0	2	0	2	2	**11**
7	M	H	LY			A	0	0	0	0	2	0	0	0	0	0	**2**	0	0	0	0	0	0	0	0	0	0	**0**
6	F	H	LY			A	0	0	0	0	2	0	0	2	0	0	**4**	2	0	0	0	0	0	0	0	0	2	**4**
7	M	H	LY			A	0	0	0	0	2	0	2	2	0	0	**6**	2	0	2	0	0	0	0	0	0	2	**6**
8	F	H	LY			A	0	0	2	0	0	0	1	2	0	0	**5**	2	0	1	0	1	1	2	0	2	2	**11**
6	F	H	LY			A	2	2	1	0	2	1	0	1	2	0	**11**	2	2	2	2	2	2	2	2	2	1	**19**
8	M	H	LY1+	K		A	2	0	2	0	2	0	2	1	2	0	**11**	2	0	2	0	2	0	2	0	2	1	**11**
8	M	A	LY1+			A	0	0	0	1	0	0	1	0	0	0	**2**	2	0	1	0	1	0	2	0	0	0	**6**
8	F	H	LY1+			A	2	2	2	2	1	1	1	2	2	0	**15**	0	0	1	0	2	1	2	0	2	0	**8**
6	M	H	LY1+			A	2	1	2	1	2	1	2	2	2	0	**15**	2	1	2	2	2	2	2	2	2	2	**19**
6	M	H	LY2+			A	1	0	2	0	2	1	1	0	1	1	**9**	2	0	2	1	1	0	0	1	1	0	**8**
7	M	H	LY2+			A	2	0	2	1	0	0	1	2	2	0	**10**	2	0	1	1	1	0	2	0	2	2	**11**
6	M	H	LY2+			A	2	0	2	0	0	0	2	0	0	0	**6**	0	2	2	0	2	0	2	2	0	0	**10**
7	F	W	LY2+			A	2	0	2	0	0	0	2	1	2	0	**9**	0	0	2	2	2	0	2	0	2	0	**10**
6	M	H	LY3+	K		A	2	1	2	0	0	1	2	2	2	0	**12**	2	0	1	1	2	0	2	2	2	2	**14**
6	M	H	LY3+	S		A											**0**											**0**
8	F	A	LY3+			A	2	0	2	0	2	1	0	0	2	0	**9**	2	1	2	2	1	0	2	2	2	1	**15**
7	M	H	LY3+			A	0	0	2	0	0	0	2	0	2	0	**6**	2	0	2	2	2	0	2	2	2	1	**15**
6	M	H	LY4+			A	2	0	2	1	1	1	1	2	2	0	**12**	1	1	1	2	2	2	2	2	2	2	**17**
6	M	H	LY6+	K		A	2	2	2	1	2	1	1	1	2	1	**15**	1	0	2	0	1	1	2	0	1	0	**8**
6	M	H	LY6+			A	2	0	2	0	0	2	0	0	2	0	**8**	0	0	1	0	2	2	2	0	2	0	**9**
6	M	H	LY6+			A	2	1	2	0	2	1	0	2	2	1	**13**	2	1	1	0	2	2	2	2	2	2	**16**
8	F	H	LZ	H		A	2	0	1	0	2	1	2	0	0	0	**8**	2	1	2	1	1	1	1	0	1	0	**10**
8	M	A	LZ	K		A	2	0	2	2	1	2	2	2	2	0	**15**	2	0	2	2	2	2	2	0	2	2	**16**
8	M	H	LZ	K		A	2	2	2	0	2	1	2	0	2	0	**13**	2	2	2	0	2	1	2	0	2	0	**13**
8	M	A	LZ	KG		A	0	2	2	0	0	0	2	2	1	0	**9**	0	2	2	0	2	0	2	0	1	2	**11**
8	M	H	LZ			A	2	0	1	0	1	2	2	2	1	0	**11**	2	2	2	2	2	2	1	2	1	2	**18**
6	F	W	TN			A	2	1	2	0	1	1	1	0	2	2	**12**	1	2	1	1	2	1	2	2	2	1	**15**
6	M	M	ZZ	G		A	0	1	2	0	0	0	2	2	2	0	**9**	0	1	2	2	2	2	2	2	2	2	**17**
6	M	W	ZZ	J		A	2	0	2	0	2	0	2	1	2	0	**11**	2	0	2	2	2	2	2	2	2	1	**17**
7	M	W	ZZ	K		A	2	2	2	2	2	1	2	1	2	0	**16**	2	1	1	1	1	0	2	0	2	0	**10**
7	M	W	ZZ	K		A	2	1	2	2	2	1	2	2	2	0	**16**	2	0	2	0	1	0	2	1	2	2	**12**
7	M	W	ZZ	K		A											**0**											**0**
8	F	W	ZZ	K		A	2	0	2	1	1	1	2	0	2	2	**13**	1	0	2	0	2	2	2	2	2	0	**13**
8	M	W	ZZ	K		A																						
8	M	W	ZZ	K		A	2	2	2	2	2	0	2	1	2	0	**15**	2	2	2	2	2	2	2	0	2	1	**17**
7	M	W	ZZ	K		A	0	0	2	0	1	1	0	0	2	0	**6**	2	0	2	0	0	1	2	0	2	0	**9**
7	F	W	ZZ	K		A	2	0	2	0	2	2	2	2	2	0	**14**	2	0	2	2	2	2	2	2	2	2	**18**
6	F	W	ZZ	K		A	0	0	1	0	0	0	0	0	2	0	**3**	2	0	2	2	0	0	1	1	2	0	**10**
7	F	W	ZZ	V		A	2	0	2	0	1	1	2	1	2	2	**13**	1	0	2	2	2	1	2	2	2	2	**16**
6	M	W	ZZ	V		A	2	2	2	0	0	1	0	2	2	0	**11**	0	2	2	0	2	1	2	2	2	2	**15**
6	M	W	ZZ	W		A	2	0	2	0	0	0	2	1	2	0	**9**	1	0	2	0	1	0	2	0	2	0	**8**
8	F	B	ZZ			A	2	0	2	2	2	2	2	1	2	2	**17**	2	0	2	2	2	2	2	2	2	1	**17**
6	M	B	ZZ			A	0	0	2	1	0	0	0	0	2	0	**5**	0	0	1	1	0	0	2	0	2	1	**7**
6	M	B	ZZ			A	2	2	2	0	2	0	0	0	0	0	**8**	2	2	2	2	2	1	2	0	2	1	**16**
6	M	H	ZZ			A	0	0	2	0	0	0	0	0	0	0	**2**	0	0	1	0	0	0	2	0	0	0	**3**
7	F	H	ZZ			A	2	0	2	0	2	1	0	2	2	0	**11**	2	0	1	1	1	2	2	0	2	2	**13**
8	F	H	ZZ			A	2	1	2	1	2	1	2	2	2	2	**17**	2	1	2	2	2	2	2	2	2	2	**19**
6	F	H	ZZ			A	2	0	2	1	0	0	0	0	0	0	**5**	0	0	0	2	2	0	2	0	2	0	**8**
6	F	H	ZZ			A	2	0	2	0	0	2	0	1	2	0	**9**	2	0	2	0	2	2	2	0	2	0	**12**
8	F	W	ZZ			A	2	0	2	1	2	1	2	0	1	0	**11**	0	0	0	0	0	1	2	0	1	0	**4**
7	M	W	ZZ			A	2	2	2	2	2	2	1	2	2	2	**19**	2	2	2	2	2	2	2	1	2	2	**19**
8	M	W	ZZ			A	0	0	2	2	2	1	1	0	2	0	**10**	2	2	1	0	2	1	2	0	2	0	**12**
8	F	W	ZZ			A	2	2	2	0	2	2	2	1	2	1	**16**	2	2	2	2	2	2	2	2	2	1	**19**
6	M	W	ZZ			A	2	0	2	0	0	1	2	1	2	0	**10**	2	1	2	1	2	1	2	0	2	1	**14**
7	M	W	ZZ			A	2	0	2	0	2	1	2	1	2	0	**12**	2	0	2	2	2	0	2	2	2	2	**16**
8	M	W	ZZ			A	2	2	2	2	2	1	0	1	2	0	**14**	2	2	2	2	2	1	2	2	2	1	**18**
7	M	W	ZZ			A	2	2	2	0	1	0	2	0	2	0	**11**	1	2	1	2	2	2	2	0	2	2	**16**

Chapter One Test Scores
Raw Data

8	M	W	ZZ		A	2	2	2	1	1	1	2	1	2	0	**14**	2	2	2	2	2	2	2	2	1	**19**
7	F	W	ZZ		A	2	2	2	0	2	1	2	0	2	2	**15**	2	2	2	2	2	2	2	2	2	**20**
7	F	W	ZZ		A	2	0	2	0	2	1	2	1	2	0	**12**	1	2	2	2	2	2	2	2	1	**18**
8	F	W	ZZ		A	2	0	2	1	0	1	0	0	2	0	**8**	2	1	2	1	1	2	2	2	1	**16**
8	F	W	ZZ		A	1	1	1	0	0	1	0	0	2	0	**6**	2	2	2	2	1	2	2	1	2	0	**16**
6	M	H	LY		C	0	0	1	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	**0**
7	F	H	LY		C	2	0	0	0	1	0	2	2	0	0	**7**	1	0	2	0	2	0	0	0	0	2	**7**
8	F	H	LY		C	0	0	0	0	0	0	0	0	0	0	**0**	2	0	0	0	0	0	0	0	0	0	**2**
8	M	W	LY		C	0	0	2	0	1	1	2	2	0	0	**8**	1	2	2	2	1	2	2	2	0	2	**16**
6	M	H	LY1+	K	C	2	0	2	0	0	1	0	0	0	0	**5**	0	0	2	0	2	2	2	0	2	2	**12**
7	M	H	LY1+		C	2	0	0	0	0	0	0	2	1	0	**5**	0	0	2	0	1	0	0	0	1	0	**4**
8	F	H	LY1+		C	2	0	2	0	0	0	1	2	0	0	**7**	1	2	0	2	0	0	2	0	2	0	**9**
8	F	H	LY1+		C	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	1	0	0	0	0	2	0	**3**
7	M	H	LY1+		C	0	0	0	0	0	0	0	1	2	0	**3**	2	0	0	1	0	0	0	0	2	1	**6**
6	M	H	LY1+		C	2	0	2	1	0	1	1	1	1	0	**9**	1	0	2	2	2	1	2	0	2	1	**13**
6	M	H	LY1+		C	2	1	2	1	2	1	1	1	2	0	**13**	2	2	2	2	2	1	2	2	2	1	**18**
6	M	W	LY1+		C	0	0	2	0	0	0	0	1	0	0	**3**	0	1	2	2	0	0	0	0	0	0	**5**
8	M	H	LY2+	K	C	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**0**
8	M	H	LY2+		C	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**0**
7	F	H	LY2+		C	2	0	2	0	2	0	2	2	1	0	**11**	1	0	2	2	2	2	2	2	2	**17**
6	M	H	LY3+		C	2	0	2	1	0	1	2	0	2	0	**10**	0	0	2	1	2	1	2	0	2	0	**10**
6	M	H	LY4+	K	C	2	0	2	1	2	1	2	2	2	0	**14**	2	0	2	0	2	2	1	0	2	2	**13**
6	M	H	LY4+	K	C	2	2	2	2	2	2	2	2	2	2	**20**	2	2	2	2	2	2	2	2	2	2	**20**
7	M	H	LY4+	K	C	2	0	0	1	2	0	1	2	2	0	**10**	2	0	2	2	2	1	2	0	0	0	**11**
6	F	W	LY4+	K	C	2	0	2	0	0	0	0	0	0	0	**4**	0	0	2	1	2	0	2	0	0	0	**7**
7	F	H	LY4+		C	1	0	2	0	0	2	2	1	2	0	**10**	2	1	2	0	1	2	2	0	2	2	**14**
6	M	H	LY6+	K	C	2	0	2	1	0	0	0	0	0	0	**5**	0	0	1	1	2	1	2	0	2	2	**11**
6	F	H	LY6+		C	2	0	2	0	1	1	0	0	2	0	**8**	0	0	1	0	2	2	0	1	2	0	**8**
7	M	H	LY6+		C	2	0	2	2	2	1	2	1	2	2	**16**	2	0	2	2	2	2	2	2	1	**17**
6	M	H	LY6+		C	1	0	2	1	0	1	0	1	2	0	**8**	1	2	2	2	1	2	2	2	1	**17**
8	M	B	LZ	KG	C											**0**										**0**
8	M	H	LZ	KG	C	0	0	2	1	2	1	2	2	0	1	**11**	2	0	2	2	2	1	2	2	2	2	**17**
6	M	H	LZ		C	2	0	2	0	2	1	2	2	2	0	**13**	2	2	2	1	1	1	1	1	1	1	**13**
8	F	H	LZ		C	2	0	2	0	2	1	1	1	2	0	**11**	2	0	2	0	2	0	2	1	2	1	**12**
8	M	H	LZ		C	2	0	2	0	1	0	1	1	2	0	**9**	2	0	2	2	2	0	0	2	2	1	**13**
7	F	H	LZ		C	2	0	2	1	2	1	1	1	2	0	**12**	2	0	2	2	2	2	2	2	2	2	**18**
8	M	H	TN		C	2	0	1	0	0	2	0	2	2	0	**9**	1	1	1	1	1	2	1	0	1	0	**9**
7	M	H	TN		C	2	0	2	1	2	0	2	2	2	0	**13**	2	2	2	2	2	2	2	2	1	**19**
7	M	W	ZZ	J	C	2	2	1	2	1	1	2	1	2	1	**15**	1	2	2	2	2	2	2	2	2	**19**
6	M	B	ZZ	K	C	1	2	1	1	2	1	2	1	2	0	**13**	2	0	0	1	2	2	2	0	2	1	**12**
8	M	B	ZZ	K	C	0	0	1	0	1	0	0	1	2	0	**5**	2	0	1	0	0	0	1	0	2	1	**7**
7	F	B	ZZ	K	C	2	2	2	2	2	1	2	2	2	0	**17**	2	2	2	2	2	1	2	2	2	2	**19**
6	M	W	ZZ	K	C	1	0	2	1	0	1	1	0	2	0	**8**	0	0	1	0	2	1	2	2	2	0	**10**
8	F	W	ZZ	K	C	2	0	2	1	1	1	1	1	2	0	**11**	2	0	2	2	2	1	2	2	2	0	**15**
7	M	W	ZZ	K	C	2	0	2	0	2	1	2	2	2	0	**13**	2	1	2	2	2	0	2	2	2	2	**17**
7	M	W	ZZ	K	C	2	0	2	0	2	1	2	1	0	0	**10**	2	0	2	1	2	2	2	2	2	1	**16**
6	F	W	ZZ	K	C	0	0	2	1	0	1	0	0	2	0	**6**	0	2	2	2	2	0	2	2	2	0	**14**
8	M	A	ZZ	KG	C	2	0	2	0	0	1	2	0	2	0	**9**	2	0	2	0	2	0	2	0	2	0	**10**
6	M	W	ZZ	V	C	2	0	2	0	0	1	0	0	2	0	**7**	0	2	2	2	2	0	2	0	2	0	**12**
7	M	B	ZZ		C	2	0	2	1	2	2	1	1	2	0	**13**	2	2	2	2	2	2	2	2	2	1	**19**
8	F	H	ZZ		C	2	0	2	0	1	1	0	1	2	0	**9**	1	0	2	0	2	0	2	0	2	0	**9**
6	F	H	ZZ		C	2	1	2	2	2	1	0	1	2	0	**13**	2	1	1	2	2	2	2	2	2	1	**17**
8	M	W	ZZ		C											**0**											**0**
8	M	W	ZZ		C	2	0	2	0	2	1	2	1	2	0	**12**	2	0	2	2	2	0	2	0	2	1	**13**
7	F	W	ZZ		C	2	1	2	1	2	1	2	1	2	0	**14**	2	1	2	2	2	2	2	0	2	0	**15**
7	F	W	ZZ		C	2	1	2	1	1	2	2	1	2	2	**16**	2	2	2	1	2	2	2	2	2	2	**19**
7	F	W	ZZ		C	2	0	2	0	0	1	2	0	0	0	**7**	1	2	0	2	1	2	1	0	2	0	**11**
8	M	W	ZZ		C	2	1	2	0	0	1	0	1	2	0	**9**	0	2	0	2	2	0	2	2	2	1	**13**
7	M	W	ZZ		C	2	0	2	0	2	2	2	0	1	0	**11**	2	0	2	2	2	2	2	2	1	0	**15**
7	F	W	ZZ		C	1	0	2	0	2	1	2	1	2	0	**11**	2	0	2	2	2	0	2	2	2	2	**16**
8	M	W	ZZ		C	2	0	2	0	1	1	2	2	2	0	**12**	2	1	1	2	2	2	2	1	2	2	**17**
6	F	W	ZZ		C	0	0	2	0	0	1	0	1	2	0	**6**	2	0	0	2	2	2	2	1	2	0	**13**
6	M	W	ZZ		C	0	0	2	0	2	0	0	0	1	0	**5**	2	1	2	2	0	1	2	2	2	0	**14**
6	M	W	ZZ		C											**0**											**0**
6	F	W	ZZ		C											**0**											**0**

CHAPTER TWO TEST SCORES
RAW DATA

grade	gender	ethnicity	LY	ESE	Group	converging 1	twig 1	kindling 1	refugee camp	well / well water 1	beam / crossbeam 1	sarong 1	dipper / ladle 1	mat / sleeping mat 1	barren 1	**sum chp 2 pre**	refugee camp 2	twig 2	beam / crossbeam 2	converging 2	well / well water 2	kindling 2	barren 2	dipper / ladle 2	mat/ sleeping mat2	sarong 2	**sum chp 2 post**
8	M	B	LY		A	0	0	0	2	0	0	0	0	0	0	**2**	2	0	0	0	2	0	0	0	2	0	**6**
7	M	H	LY		A	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**0**
6	F	H	LY		A											**0**											**0**
7	M	H	LY		A	0	0	0	0	2	0	0	0	1	0	**3**	0	0	0	0	1	0	0	0	0	0	**1**
8	F	H	LY		A	2	0	0	1	2	0	0	0	0	0	**5**	0	0	0	2	2	0	0	0	2	0	**6**
6	F	H	LY		A	0	2	0	0	2	0	0	0	2	0	**6**	2	2	0	0	2	0	0	0	2	0	**8**
8	M	H	LY1+	K	A	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	2	0	**2**
8	M	A	LY1+		A	0	0	0	1	2	0	0	0	0	0	**3**	1	0	0	1	2	0	0	0	2	0	**6**
8	F	H	LY1+		A	0	0	0	1	1	0	0	0	2	0	**4**	1	0	0	0	2	0	0	0	2	0	**5**
6	M	H	LY1+		A	0	2	0	2	2	1	0	2	2	2	**13**	2	2	1	0	2	0	2	2	2	2	**15**
6	M	H	LY2+		A	0	0	0	2	1	0	0	0	2	0	**5**	2	2	0	0	1	0	0	0	2	0	**7**
7	M	H	LY2+		A	0	2	1	1	0	1	0	1	2	0	**8**	2	2	0	0	1	0	0	1	2	0	**8**
6	M	H	LY2+		A	0	0	0	0	1	0	0	0	1	0	**2**	1	0	0	1	1	0	0	0	2	0	**5**
7	F	W	LY2+		A	0	0	0	0	2	0	0	0	0	0	**2**	0	0	0	0	2	0	0	0	2	0	**4**
6	M	H	LY3+	K	A	0	2	0	0	0	1	0	0	2	0	**5**	0	2	1	0	0	0	0	1	2	2	**8**
6	M	H	LY3+	S	A											**0**											**0**
8	F	A	LY3+		A	0	2	0	0	1	0	0	0	2	0	**5**	0	2	1	0	2	0	1	2	2	0	**10**
7	M	H	LY3+		A	0	2	0	0	1	0	0	0	2	0	**5**	2	2	1	0	2	0	0	1	2	0	**10**
6	M	H	LY4+		A	0	0	0	1	1	0	0	0	1	0	**3**	1	0	0	0	1	0	0	0	2	0	**4**
6	M	H	LY6+	K	A	0	2	0	2	2	1	0	1	2	0	**10**	2	2	1	0	1	0	0	0	2	0	**8**
6	M	H	LY6+		A	0	1	0	0	0	0	0	0	2	0	**3**	0	1	0	0	2	0	0	0	2	0	**5**
6	M	H	LY6+		A	0	2	0	0	1	1	0	1	0	0	**5**	0	2	1	0	2	0	0	1	2	0	**8**
8	F	H	LZ	H	A	2	0	0	1	1	0	0	1	2	2	**9**	1	0	0	2	1	1	2	2	1	1	**11**
8	M	A	LZ	K	A	0	2	0	1	2	1	0	2	2	2	**12**	2	2	1	0	2	0	2	2	2	0	**13**
8	M	H	LZ	K	A	0	0	0	0	2	0	0	0	0	0	**2**	0	0	0	2	2	0	1	0	2	0	**7**
8	M	A	LZ	KG	A	0	2	0	0	2	0	0	0	2	0	**6**	0	2	0	0	2	0	0	0	2	0	**6**
8	M	H	LZ		A	0	2	0	1	0	1	0	0	2	2	**8**	1	2	1	0	1	0	2	0	2	0	**9**
6	F	W	TN		A	0	2	0	1	1	0	0	0	2	0	**6**	1	2	0	0	1	0	0	0	2	0	**6**
6	M	M	ZZ	G	A	0	2	0	0	1	0	0	0	0	0	**3**	1	2	0	0	2	0	0	2	2	0	**9**
6	M	W	ZZ	J	A											**0**											**0**
7	M	W	ZZ	K	A	0	2	0	0	2	2	0	1	2	0	**9**	1	2	2	0	2	2	2	1	2	0	**14**
7	M	W	ZZ	K	A	0	2	1	1	2	2	0	2	2	1	**13**	2	2	2	0	2	1	1	2	2	0	**14**
7	M	W	ZZ	K	A	0	2	0	2	2	1	0	0	2	0	**9**	2	2	1	0	2	0	2	2	2	0	**13**
8	F	W	ZZ	K	A	0	2	0	0	2	1	0	0	1	2	**8**	1	2	1	0	2	0	2	2	1	0	**11**
8	M	W	ZZ	K	A																						
8	M	W	ZZ	K	A	2	2	0	0	0	0	0	2	2	2	**10**	2	2	2	2	2	2	2	2	2	0	**18**
7	M	W	ZZ	K	A	0	0	0	0	2	0	0	0	2	0	**4**	2	2	0	0	2	0	0	0	2	0	**8**
7	F	W	ZZ	K	A	0	2	0	0	2	0	0	2	2	0	**8**	0	2	0	0	2	0	0	2	2	2	**10**
6	F	W	ZZ	K	A	0	2	0	0	2	0	0	0	1	0	**5**	2	2	2	0	2	0	0	2	1	0	**11**
7	F	W	ZZ	V	A	0	2	0	0	2	1	0	1	2	0	**8**	2	2	1	0	1	0	0	0	2	0	**8**
6	M	W	ZZ	V	A	0	2	0	0	1	0	0	0	2	0	**5**	2	2	0	0	2	0	0	0	2	0	**8**
6	M	W	ZZ	W	A	0	2	0	0	2	0	0	0	2	0	**6**	0	2	0	0	1	0	0	0	2	0	**5**
8	F	B	ZZ		A	1	2	0	2	2	1	0	2	2	2	**14**	2	2	1	1	2	0	2	2	2	0	**14**
6	M	B	ZZ		A	0	2	0	0	1	1	0	1	2	0	**7**	1	2	0	0	1	2	0	0	2	1	**9**
6	M	B	ZZ		A	0	2	0	0	0	0	0	0	1	0	**3**	0	2	0	0	0	0	0	0	1	0	**3**
6	M	H	ZZ		A	2	2	0	0	1	0	0	0	2	0	**7**	1	2	0	2	1	0	0	0	2	0	**8**
7	F	H	ZZ		A	0	2	0	0	2	0	0	0	2	0	**6**	2	2	0	0	2	2	0	2	2	0	**12**
8	F	H	ZZ		A	0	2	0	2	2	1	0	0	1	0	**8**	2	2	1	2	2	0	0	1	2	0	**12**
6	F	H	ZZ		A	0	0	0	0	1	0	0	1	2	0	**4**	0	2	0	2	1	2	0	1	2	0	**10**
6	F	H	ZZ		A	0	2	0	0	0	0	0	0	2	0	**4**	0	2	0	0	0	0	0	0	2	0	**4**
8	F	W	ZZ		A	0	1	0	0	1	0	0	1	2	0	**5**	0	0	0	0	2	0	0	0	0	0	**2**
7	M	W	ZZ		A	0	2	2	2	2	1	0	2	2	0	**13**	2	2	2	0	2	2	0	2	2	2	**16**
8	M	W	ZZ		A	2	2	0	1	1	0	0	2	2	2	**12**	1	2	0	2	1	0	2	2	2	0	**12**
8	F	W	ZZ		A	0	2	0	1	2	0	0	2	2	2	**11**	1	2	1	0	2	2	2	2	2	2	**16**
6	M	W	ZZ		A											**0**											**0**
7	M	W	ZZ		A	2	2	2	2	2	1	0	2	2	2	**17**	2	2	1	2	2	2	2	2	2	2	**19**
8	M	W	ZZ		A	0	2	0	0	2	1	0	2	2	2	**11**	2	2	1	2	2	0	2	2	2	0	**15**
7	M	W	ZZ		A	0	2	0	1	2	0	0	0	0	0	**5**	1	2	0	0	2	1	0	2	0	2	**10**

CHAPTER TWO TEST SCORES
RAW DATA

8	M	W	ZZ		A	0	2	2	0	2	2	0	0	2	2	**12**	2	2	2	0	2	2	2	2	2	2	**18**
7	F	W	ZZ		A	1	2	0	1	2	1	0	2	2	0	**11**	2	2	1	1	2	0	0	2	2	0	**12**
7	F	W	ZZ		A	2	2	0	2	2	1	0	2	2	2	**15**	2	2	1	2	2	0	1	2	2	0	**14**
8	F	W	ZZ		A	0	2	0	0	2	0	0	0	2	2	**8**	0	2	0	0	1	0	2	0	2	0	**7**
8	F	W	ZZ		A	0	2	0	2	2	0	0	0	2	0	**8**	2	2	1	0	2	0	0	1	2	2	**12**
6	M	H	LY		C	2	0	0	0	2	0	0	0	0	0	**4**	0	0	0	0	0	0	0	0	0	0	**0**
7	F	H	LY		C	0	0	0	0	1	0	0	0	2	0	**3**	2	0	0	0	0	0	0	0	2	0	**4**
8	F	H	LY		C	0	0	0	0	1	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	**0**
8	M	W	LY		C	0	2	0	0	2	0	0	0	2	0	**6**	0	2	0	0	2	0	0	2	2	0	**8**
6	M	H	LY1+	K	C	0	2	0	0	0	0	0	0	2	0	**4**	2	2	0	0	0	0	0	0	2	0	**6**
7	M	H	LY1+		C	0	0	0	0	1	0	0	0	0	0	**1**	0	0	0	0	2	0	0	0	0	0	**2**
8	F	H	LY1+		C	0	0	0	1	2	0	0	0	2	0	**5**	1	0	0	0	2	0	0	0	2	0	**5**
8	F	H	LY1+		C	0	0	0	1	2	0	0	0	2	0	**5**	1	0	0	0	2	0	0	0	2	0	**5**
7	M	H	LY1+		C	0	0	0	2	2	0	0	0	2	0	**6**	2	0	0	0	2	1	0	0	2	0	**7**
6	M	H	LY1+		C	1	0	0	2	1	0	0	0	0	0	**4**	0	0	0	1	0	0	0	0	0	0	**1**
6	M	H	LY1+		C	0	2	0	1	2	0	0	0	2	0	**7**	2	2	1	0	2	0	0	0	2	0	**9**
6	M	W	LY1+		C	0	0	0	0	0	0	0	0	2	0	**2**	2	0	0	0	1	0	0	0	2	0	**5**
8	M	H	LY2+	K	C	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**0**
8	M	H	LY2+		C	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**0**
7	F	H	LY2+		C	0	0	0	1	2	0	0	0	2	0	**5**	2	2	0	0	2	2	0	0	2	0	**10**
6	M	H	LY3+		C	0	0	0	0	0	0	0	0	2	0	**2**	1	0	0	0	1	0	0	0	2	0	**4**
6	M	H	LY4+	K	C	0	0	0	0	0	0	0	0	2	0	**2**	2	0	0	0	0	0	0	0	2	0	**4**
6	M	H	LY4+	K	C	0	2	0	2	1	1	0	0	0	0	**6**	2	2	0	0	1	0	0	0	2	0	**7**
7	M	H	LY4+	K	C	0	2	0	1	2	0	0	0	2	0	**7**	0	2	0	0	2	0	0	0	0	1	**5**
6	F	W	LY4+	K	C	0	1	0	1	2	0	0	0	2	0	**6**	0	2	0	0	2	0	0	0	0	0	**4**
7	F	H	LY4+		C	0	0	0	0	0	0	0	1	0	0	**1**	2	2	0	0	0	0	0	2	1	0	**7**
6	M	H	LY6+	K	C	0	2	0	0	2	0	0	2	2	0	**8**	0	2	0	0	1	0	0	2	2	0	**7**
6	F	H	LY6+		C	0	2	0	0	1	0	0	0	0	0	**3**	0	2	0	0	2	0	0	0	2	0	**6**
7	M	H	LY6+		C	0	0	0	2	2	1	0	1	0	0	**6**	2	0	1	0	2	0	2	0	0	0	**7**
6	M	H	LY6+		C	0	0	0	0	1	1	0	0	0	0	**2**	2	2	1	0	1	0	0	0	2	0	**8**
8	M	B	LZ	KG	C	0	0	0	0	1	0	0	0	1	0	**2**	2	0	0	0	1	0	0	0	2	0	**5**
8	M	H	LZ	KG	C	0	2	0	0	2	0	0	0	2	0	**6**	0	2	0	0	2	0	0	2	2	0	**8**
6	M	H	LZ		C											**0**											**0**
8	F	H	LZ		C	0	2	0	0	2	0	0	0	2	0	**6**	2	0	0	0	2	0	0	1	2	1	**8**
8	M	H	LZ		C	0	2	0	0	0	0	0	0	2	0	**4**	1	2	0	0	1	2	2	0	2	0	**10**
7	F	H	LZ		C	0	2	0	1	2	1	0	0	1	0	**7**	1	2	2	0	2	1	0	0	2	2	**12**
8	M	H	TN		C	0	2	0	0	0	0	0	0	2	0	**4**	0	2	0	0	2	0	0	0	2	0	**6**
7	M	H	TN		C	2	2	0	1	2	1	0	2	2	0	**12**	2	2	1	2	1	0	0	2	2	0	**12**
7	M	W	ZZ	J	C	2	2	2	1	1	0	0	2	2	0	**12**	1	2	2	2	2	2	1	2	2	2	**18**
6	M	B	ZZ	K	C	0	2	0	1	1	0	0	0	2	0	**6**	1	2	0	2	1	0	2	2	2	0	**12**
8	M	B	ZZ	K	C	0	0	0	0	1	0	0	0	2	0	**3**	0	0	0	0	1	0	0	0	2	0	**3**
7	F	B	ZZ	K	C	0	2	0	0	0	0	0	0	2	0	**4**	2	2	2	0	2	0	0	2	2	2	**14**
6	M	W	ZZ	K	C	0	2	0	2	2	0	0	1	2	0	**9**	2	2	0	0	2	0	0	0	2	0	**8**
8	F	W	ZZ	K	C	0	2	0	2	2	1	0	0	2	0	**9**	2	2	1	0	2	0	0	0	2	0	**9**
7	M	W	ZZ	K	C	0	2	2	0	2	0	0	0	2	0	**8**	2	2	1	2	2	2	0	2	2	0	**15**
7	M	W	ZZ	K	C	0	2	0	0	2	0	0	2	2	0	**8**	2	2	2	0	2	0	0	2	2	0	**12**
6	F	W	ZZ	K	C	0	2	0	0	0	0	0	0	0	0	**2**	0	2	0	0	2	0	0	2	2	0	**8**
8	M	A	ZZ	KG	C	0	2	0	0	0	1	0	0	0	0	**3**	2	2	0	0	2	0	0	0	2	0	**8**
6	M	W	ZZ	V	C	2	2	0	2	0	0	0	0	2	0	**8**	2	2	0	2	2	0	0	0	0	0	**8**
7	M	B	ZZ		C	0	2	0	2	0	0	0	0	2	0	**6**	2	2	0	2	2	0	0	2	2	0	**12**
8	F	H	ZZ		C	0	2	0	0	1	0	0	1	0	0	**4**	0	2	0	2	1	0	0	1	2	0	**8**
6	F	H	ZZ		C	0	2	0	0	2	1	0	0	2	0	**7**	2	2	1	0	2	0	0	0	2	0	**9**
8	M	W	ZZ		C	0	2	0	0	1	0	0	0	2	0	**5**	2	0	2	0	1	0	2	2	2	0	**11**
8	M	W	ZZ		C	2	2	2	1	1	0	0	2	2	2	**14**	2	2	0	2	2	2	2	2	2	0	**16**
7	F	W	ZZ		C	2	2	0	0	2	1	0	0	2	0	**9**	0	2	1	0	2	0	0	0	2	0	**7**
7	F	W	ZZ		C	0	2	0	1	2	1	0	1	2	0	**9**	2	2	0	0	2	0	0	2	2	0	**10**
7	F	W	ZZ		C	0	0	0	0	1	0	0	0	2	0	**3**	0	2	0	0	1	0	0	0	1	0	**4**
8	M	W	ZZ		C	0	2	0	1	2	1	0	0	2	2	**10**	0	2	1	0	2	1	2	0	2	2	**12**
7	M	W	ZZ		C	0	2	0	0	1	0	0	1	1	0	**5**	1	2	1	1	1	0	1	1	2	0	**10**
7	F	W	ZZ		C	2	2	0	1	2	0	0	1	2	0	**10**	1	2	0	2	2	0	1	2	2	0	**12**
8	M	W	ZZ		C	2	2	0	1	1	0	0	2	2	2	**12**	1	2	0	2	1	0	2	2	2	0	**12**
6	F	W	ZZ		C	0	2	0	0	0	0	0	0	0	0	**2**	2	2	0	0	1	0	0	0	1	0	**6**
6	M	W	ZZ		C	0	2	0	0	0	1	0	1	1	0	**5**	2	2	1	0	2	0	0	0	1	0	**8**
6	M	W	ZZ		C	0	2	0	1	2	0	0	0	2	2	**9**	0	2	0	0	2	0	2	0	2	0	**8**
6	F	W	ZZ		C											**0**											**0**

COMPREHENSION SCORES
DELTA SCORES PER WORD

grade	gender	ethnicity	LY	ESE	Group	why traveling	who with	to where	hope to find	feel	d cowbell	d oxen	d forest	d cart/oxcart	d the border	d cartwheel	d rice seed	d temple	d village	d gunnysack	**d chp 1**	d converging	d twig	d kindling	d refugee camp	d well / well water	d beam / crossbeam	d sarong	d dipper / ladle	d mat/sleeping mat	d barren	**d chp 2**	**sum comp**
8	M	B	LY		A	1	1	0	1	1	2	0	0	0	2	0	0	0	0	0	**4**	0	0	0	0	2	0	0	0	2	0	**4**	**4**
7	M	H	LY		A	0	0	0	0	0	0	0	0	0	-2	0	0	0	0	0	**-2**	0	0	0	0	0	0	0	0	0	0	**0**	**0**
6	F	H	LY		A						0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0		**0**
7	M	H	LY		A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	-1	0	0	0	-1	0	**-2**	**0**
8	F	H	LY		A						1	0	0	0	2	1	0	0	2	0	**6**	0	0	0	-1	0	0	0	0	2	0	**1**	**0**
6	F	H	LY		A	1	2	2	1	1	0	0	1	2	0	1	2	0	0	2	**8**	0	0	0	2	0	0	0	0	0	0	**2**	**7**
8	M	H	LY1+	K	A	1	1	1	2	1	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	2	0	**2**	**6**
8	M	A	LY1+		A	2	1	2	1	0	1	0	2	-1	2	0	0	0	0	0	**4**	1	0	0	0	0	0	0	0	2	0	**3**	**6**
8	F	H	LY1+		A	0	0	0	0	1	0	-2	0	-2	-1	0	0	-2	0	0	**-7**	0	0	0	0	1	0	0	0	0	0	**1**	**1**
6	M	H	LY1+		A	1	2	2	2	2	0	0	0	1	0	1	0	0	0	2	**4**	0	0	0	0	0	0	2	0	0	0	**2**	**9**
6	M	H	LY2+		A	0	0	0	0	0	0	0	-2	1	0	-1	1	0	0	0	**-1**	0	2	0	0	0	0	0	0	0	0	**2**	**0**
7	M	H	LY2+		A	0	1	0	0	1	-1	0	0	0	2	0	0	0	0	0	**1**	0	0	-1	1	1	-1	0	0	0	0	**0**	**2**
6	M	H	LY2+		A	1	0	1	1	0	0	2	0	0	0	0	0	0	0	2	**4**	1	0	0	1	0	0	0	0	1	0	**3**	**3**
7	F	W	LY2+		A	2	2	2	1	2	0	0	0	2	0	0	0	-1	0	0	**1**	0	0	0	0	0	0	0	2	0	**2**	**9**
6	M	H	LY3+	K	A	0	0	1	0	1	0	-1	0	1	2	-1	-1	0	0	2	**2**	0	0	0	0	0	0	2	1	0	0	**3**	**2**
6	M	H	LY3+	S	A						0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	**0**	**0**
8	F	A	LY3+		A	1	1	2	1	2	-1	1	0	2	0	-1	2	1	0	2	**6**	0	0	0	0	1	1	0	2	0	1	**5**	**7**
7	M	H	LY3+		A	0	0	2	0	0	2	0	0	2	2	0	0	1	0	2	**9**	0	0	0	2	1	1	0	1	0	0	**5**	**2**
6	M	H	LY4+		A	2	1	2	2	1	0	1	0	1	0	1	0	0	0	2	**5**	0	0	0	0	0	0	0	0	1	0	**1**	**8**
6	M	H	LY6+	K	A	0	0	0	0	0	-1	-2	0	-1	-1	0	1	-1	-1	-1	**-7**	0	0	0	0	-1	0	0	-1	0	0	**-2**	**0**
6	M	H	LY6+		A	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**1**	0	0	0	0	2	0	0	0	0	0	**2**	**0**
6	M	H	LY6+		A	1	0	2	0	1	0	0	0	0	0	1	1	0	0	1	**3**	0	0	0	0	1	0	0	0	2	0	**3**	**4**
8	F	H	LZ	H	A	1	0	0	1	1	-1	1	0	1	0	0	0	0	1	0	**2**	0	0	1	0	0	0	1	1	-1	0	**2**	**3**
8	M	A	LZ	K	A	1	0	2	0	2	0	0	0	0	0	1	0	0	0	0	**1**	0	0	0	1	0	0	0	0	0	0	**1**	**5**
8	M	H	LZ	K	A	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**0**	2	0	0	0	0	0	0	0	2	1	**5**	**1**
8	M	A	LZ	KG	A	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	**2**	0	0	0	0	0	0	0	0	0	0	**0**	**1**
8	M	H	LZ		A	1	1	0	1	0	0	2	0	2	1	0	0	0	0	2	**7**	0	0	0	0	1	0	0	0	0	0	**1**	**3**
6	F	W	TN		A	1	1	0	2	2	0	1	0	1	0	0	0	1	0	0	**3**	0	0	0	0	0	0	0	0	0	0	**0**	**6**
6	M	M	ZZ	G	A	2	1	1	2	2	2	0	0	2	0	2	0	0	0	2	**8**	0	0	0	1	1	0	0	2	2	0	**6**	**8**
6	M	W	ZZ	J	A						0	0	0	2	0	2	0	0	0	2	**6**	0	0	0	0	0	0	0	0	0	0		**0**
7	M	W	ZZ	K	A	1	0	2	2	1	-1	-1	0	-1	0	-1	-1	-1	0	0	**-6**	0	0	2	1	0	0	0	0	0	2	**5**	**6**
7	M	W	ZZ	K	A	1	0	2	1	1	-1	-1	0	-2	0	-1	0	0	0	1	**-4**	0	0	0	1	0	0	0	0	0	0	**1**	**5**
7	M	W	ZZ	K	A	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	2	0	2	**4**	**3**
8	F	W	ZZ	K	A	0	0	1	1	1	0	0	0	-1	0	1	0	0	0	0	**0**	0	0	0	1	0	0	0	2	0	0	**3**	**3**
8	M	W	ZZ	K	A						0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**0**	**0**
8	M	W	ZZ	K	A	1	1	1	1	2	0	0	0	0	0	2	0	0	0	0	**2**	0	0	2	2	2	2	0	0	0	0	**8**	**6**
7	M	W	ZZ	K	A	1	0	2	1	1	0	0	0	0	1	0	2	0	0	0	**3**	0	2	0	2	0	0	0	0	0	0	**4**	**5**
7	F	W	ZZ	K	A	1	2	2	1	1	0	0	0	2	0	0	0	0	0	2	**4**	0	0	0	0	0	0	2	0	0	0	**2**	**7**
6	F	W	ZZ	K	A	0	0	0	1	1	0	0	0	2	2	0	2	0	0	1	**7**	0	0	0	2	0	2	0	2	0	0	**6**	**2**
7	F	W	ZZ	V	A	1	1	1	0	1	0	0	0	2	0	0	0	1	0	0	**3**	0	0	0	2	-1	0	0	-1	0	0	**0**	**4**
6	M	W	ZZ	V	A	1	0	0	0	0	0	0	0	0	0	0	2	0	0	2	**4**	0	0	0	2	1	0	0	0	0	0	**3**	**1**
6	M	W	ZZ	W	A	0	1	1	0	1	-1	0	0	0	1	0	0	-1	0	0	**-1**	0	0	0	0	-1	0	0	0	0	0	**-1**	**3**
8	F	B	ZZ		A	1	1	1	2	1	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**0**	**6**
6	M	B	ZZ		A	1	0	2	0	1	0	0	0	0	0	0	1	1	0	0	**2**	0	0	2	1	0	-1	1	-1	0	0	**2**	**4**
6	M	B	ZZ		A	2	1	1	2	2	0	0	0	2	0	1	2	1	2	0	**8**	0	0	0	0	0	0	0	0	0	0	**0**	**8**
6	M	H	ZZ		A	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	**1**	0	0	0	1	0	0	0	0	0	0	**1**	**3**
7	F	H	ZZ		A	0	0	0	0	0	-1	0	0	1	0	1	1	0	0	0	**2**	0	0	2	2	0	0	0	2	0	0	**6**	**0**
8	F	H	ZZ		A	2	1	2	2	1	0	0	0	1	0	1	0	0	0	0	**2**	2	0	0	0	0	0	0	1	1	0	**4**	**8**
6	F	H	ZZ		A	1	1	1	1	1	0	0	0	1	0	0	0	0	2	0	**3**	2	2	2	0	0	0	0	0	0	0	**6**	**5**
6	F	H	ZZ		A	0	0	0	0	2	0	0	0	0	2	0	2	-1	0	0	**3**	0	0	0	0	0	0	0	0	0	0	**0**	**2**
8	F	W	ZZ		A	2	2	2	2	1	-2	0	0	-1	-2	0	-2	0	0	0	**-7**	0	-1	0	0	1	0	0	-1	-2	0	**-3**	**9**
7	M	W	ZZ		A	2	1	2	2	2	0	0	0	0	0	0	1	0	0	-1	**0**	0	0	0	0	0	1	2	0	0	0	**3**	**9**
8	M	W	ZZ		A	1	0	1	1	0	2	2	0	-2	0	0	0	0	0	0	**2**	0	0	0	0	0	0	0	0	0	0	**0**	**3**
8	F	W	ZZ		A	1	2	2	2	2	0	0	0	2	0	0	0	0	0	1	**3**	0	0	2	0	0	1	2	0	0	0	**5**	**9**
6	M	W	ZZ		A						0	1	0	1	2	0	0	0	0	0	**4**	0	0	0	0	0	0	0	0	0	0		**0**
7	M	W	ZZ		A	0	0	0	1	1	0	0	0	2	0	-1	0	1	0	2	**4**	0	0	0	0	0	0	2	0	0	0	**2**	**2**
8	M	W	ZZ		A	1	0	0	1	0	0	0	0	0	0	0	2	0	0	2	**4**	2	0	0	2	0	0	0	0	0	0	**4**	**2**
7	M	W	ZZ		A	1	1	2	1	2	0	0	0	2	0	2	-1	2	0	0	**5**	0	0	1	0	0	0	2	2	0	0	**5**	**7**
8	M	W	ZZ		A	2	1	2	2	2	0	0	0	1	1	1	0	0	0	2	**5**	0	0	0	2	0	0	2	2	0	0	**6**	**9**
7	F	W	ZZ		A	1	0	2	1	2	0	0	0	2	0	1	0	2	0	0	**5**	0	0	0	1	0	0	0	0	0	0	**1**	**6**
7	F	W	ZZ		A	1	2	2	1	1	0	2	0	2	-1	1	0	0	0	2	**6**	0	0	0	0	0	0	0	0	0	-1	**-1**	**7**
8	F	W	ZZ		A	0	0	0	0	1	-1	1	0	0	2	1	2	1	0	2	**8**	0	0	0	0	-1	0	0	0	0	0	**-1**	**1**
8	F	W	ZZ		A	2	1	2	2	2	0	1	1	2	2	1	2	0	0	1	**10**	0	0	0	0	0	1	2	1	0	0	**4**	**9**
6	M	H	LY		C	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	**-1**	-2	0	0	0	-2	0	0	0	0	0	**-4**	**0**
7	F	H	LY		C	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	2	-1	0	0	0	0	**1**	**1**
8	F	H	LY		C	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	**2**	0	0	0	0	-1	0	0	0	0	0	**-1**	**1**
8	M	W	LY		C	0	1	0	1	1	1	2	0	2	0	1	0	0	0	2	**8**	0	0	0	0	0	0	0	2	0	0	**2**	**3**

COMPREHENSION SCORES
DELTA SCORES PER WORD

6	M	H	LY1+	K	C						0	0	0	0	0	1	2	2	2	0	7	0	0	0	2	0	0	0	0	0	0	2	0
7	M	H	LY1+		C	1	0	1	0	1	-1	0	0	0	0	0	2	-2	0	0	-1	0	0	0	0	1	0	0	0	0	0	1	3
8	F	H	LY1+		C	2	1	1	1	0	-2	2	0	2	1	0	-1	-2	2	0	2	0	0	0	0	0	0	0	0	0	0	0	5
8	F	H	LY1+		C	0	0	0	1	1	0	0	0	1	0	0	0	0	2	0	3	0	0	0	0	0	0	0	0	0	0	0	2
7	M	H	LY1+		C	0	0	0	1	1	0	0	0	1	2	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0	0	1	2
6	M	H	LY1+		C	1	1	1	1	1	0	0	0	1	1	0	1	0	1	0	4	0	0	0	-2	-1	0	0	0	0	0	-3	5
6	M	H	LY1+		C	1	1	0	1	1	0	1	0	1	0	0	1	0	0	2	5	0	0	0	1	0	1	0	0	0	0	2	4
6	M	W	LY1+		C	2	0	2	0	0	0	1	-2	2	0	0	2	-1	0	0	2	0	0	0	2	1	0	0	0	0	0	3	4
8	M	H	LY2+	K	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	M	H	LY2+		C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	F	H	LY2+		C	1	1	2	1	2	0	0	0	2	-1	2	0	0	1	2	6	0	2	2	1	0	0	0	0	0	5	7
6	M	H	LY3+		C	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2	2
6	M	H	LY4+	K	C	0	1	1	1	0	0	0	-1	-1	0	1	0	0	0	0	-1	0	0	0	2	0	0	0	0	0	2	3
6	M	H	LY4+	K	C	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	2	0	1	2
7	M	H	LY4+	K	C	1	0	0	0	0	0	0	2	1	0	1	1	-2	-2	0	1	0	0	0	-1	0	0	1	0	-2	0	-2	1
6	F	W	LY4+	K	C	0	0	2	0	0	0	0	0	1	0	0	2	0	0	0	3	0	1	0	-1	0	0	0	0	-2	0	-2	2
7	F	H	LY4+		C	1	2	2	2	1	0	1	0	0	2	0	0	1	0	0	4	0	2	0	2	0	0	0	1	1	0	6	8
6	M	H	LY6+	K	C	1	0	0	1	1	0	0	0	0	0	1	1	2	2	0	6	0	0	0	0	-1	0	0	0	0	0	-1	3
6	F	H	LY6+		C	1	0	0	1	1	0	0	-2	0	-1	1	1	0	0	1	0	0	0	0	0	1	0	0	0	2	0	3	3
7	M	H	LY6+		C	1	0	2	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	-1	0	2	1	5
6	M	H	LY6+		C	1	1	2	2	1	0	2	0	1	1	1	2	0	0	2	9	0	2	0	2	0	0	0	0	2	0	6	7
8	M	B	LZ	KG	C	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	3	3
8	M	H	LZ	KG	C	2	1	0	1	1	2	0	0	1	0	0	0	0	2	1	6	0	0	0	0	0	0	0	2	0	0	2	5
6	M	H	LZ		C						-1	2	-1	1	0	0	0	-1	-1	1	0	0	0	0	0	0	0	0	0	0		0
8	F	H	LZ		C	2	2	0	0	1	0	0	0	0	0	-1	1	0	0	1	1	0	-2	0	2	0	0	1	1	0	0	2	5
8	M	H	LZ		C	1	2	2	2	2	0	0	-2	2	1	0	1	0	0	2	4	0	0	2	1	1	0	0	0	0	2	6	9
7	F	H	LZ		C	1	2	2	1	2	0	0	0	1	0	1	1	1	0	2	6	0	0	1	0	0	1	2	0	1	0	5	8
8	M	H	TN		C	1	0	0	1	0	-1	1	0	1	1	0	1	-2	-1	0	0	0	0	0	0	2	0	0	0	0	0	2	2
7	M	H	TN		C	2	1	2	1	2	0	2	0	1	0	2	0	-1	0	2	6	0	0	0	1	-1	0	0	0	0	0	0	8
7	M	W	ZZ	J	C	1	1	2	2	2	0	0	1	0	0	1	0	1	0	1	4	0	0	0	0	1	2	2	0	0	1	6	8
6	M	B	ZZ	K	C	0	0	0	1	0	1	-2	1	0	0	1	-2	0	0	0	-1	2	0	0	0	0	0	0	2	0	2	6	1
8	M	B	ZZ	K	C	0	1	0	0	1	0	0	0	0	1	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
7	F	B	ZZ	K	C	1	0	2	2	1	0	0	0	0	0	0	0	0	0	2	2	0	0	0	2	2	2	2	2	0	0	10	6
6	M	W	ZZ	K	C	0	1	1	0	0	1	0	0	-1	0	0	0	0	0	2	2	0	0	0	0	0	0	0	-1	0	0	-1	2
8	F	W	ZZ	K	C	2	1	2	1	2	0	0	0	1	1	0	1	-1	0	2	4	0	0	0	0	0	0	0	0	0	0	0	8
7	M	W	ZZ	K	C	1	0	2	0	1	0	1	0	2	0	-1	0	0	0	2	4	2	0	0	2	0	1	0	2	0	0	7	4
7	M	W	ZZ	K	C	1	1	2	1	1	0	0	0	1	0	1	0	0	2	2	6	0	0	0	2	0	2	0	0	0	0	4	6
6	F	W	ZZ	K	C	2	2	2	1	1	2	2	0	1	0	-1	2	0	0	2	8	0	0	0	0	2	0	0	2	2	0	6	8
8	M	A	ZZ	KG	C	0	0	0	0	1	0	0	0	0	2	-1	0	0	0	0	1	0	0	0	2	2	-1	0	0	2	0	5	1
6	M	W	ZZ	V	C	0	0	0	1	1	0	2	0	2	0	-1	2	0	0	0	5	0	0	0	0	2	0	0	0	-2	0	0	2
7	M	B	ZZ		C	2	2	2	1	2	0	2	0	1	0	0	1	0	0	2	6	2	0	0	0	2	0	0	2	0	0	6	9
8	F	H	ZZ		C	0	0	2	0	1	0	0	0	0	0	-1	2	-1	0	0	0	2	0	0	0	0	0	0	0	2	0	4	3
6	F	H	ZZ		C	1	2	2	1	1	0	0	0	0	0	1	1	0	0	2	4	0	0	0	2	0	0	0	0	0	0	2	7
8	M	W	ZZ		C						0	0	0	0	0	0	0	0	0	0	0	0	-2	0	2	0	2	0	2	0	6	0
8	M	W	ZZ		C	0	1	1	1	0	0	0	0	2	0	-1	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	2	3
7	F	W	ZZ		C	0	1	1	1	0	0	0	0	1	0	1	0	-1	0	0	1	-2	0	0	0	0	0	0	0	0	0	-2	3
7	F	W	ZZ		C	1	1	2	2	2	0	1	0	0	1	0	0	1	0	0	3	0	0	0	1	0	-1	0	1	0	0	1	8
7	F	W	ZZ		C	0	0	1	2	1	-1	2	-1	2	1	1	-2	0	2	0	4	0	2	0	0	0	0	0	0	-1	0	1	4
8	M	W	ZZ		C	2	1	2	1	1	0	1	0	2	0	-1	0	0	0	2	4	0	0	1	-1	0	0	2	0	0	0	2	7
7	M	W	ZZ		C	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	4	1	0	0	1	0	1	0	0	1	1	5	0
7	F	W	ZZ		C	0	0	2	1	1	1	0	0	2	0	-1	0	1	0	2	5	0	0	0	0	0	0	0	1	0	1	2	4
8	M	W	ZZ		C	2	1	2	2	2	0	1	0	2	1	1	-1	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	9
6	F	W	ZZ		C	0	0	2	1	0	2	0	0	2	2	1	0	-1	0	1	7	0	0	0	2	1	0	0	0	1	0	4	3
6	M	W	ZZ		C	2	0	0	1	1	0	1	0	2	0	1	2	0	1	2	9	0	0	0	2	2	0	0	-1	0	0	3	4
6	M	W	ZZ		C	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0		0	0	0	-1	0	0	0	0	0	-1	2
6	F	W	ZZ		C						0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX G: EXPERIMENTAL READING SLIDES

Chapter 1

I heard a cowbell. At first it was such a faint tinkling sound that I thought it was just the wind in the trees, or the shrill cry of cicadas. I looked around.

I held my breath, and kept listening.

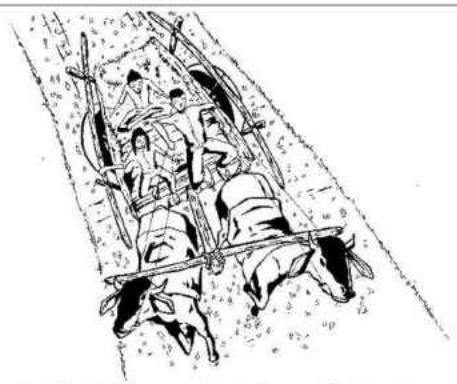
Yes, there it was again: the clear, quiet tone of a bronze bell.

"Sarun, listen!" I cried. "Can you hear it?"

My older brother turned to look at me. "Hear what?" he asked.

"A cowbell."

Dappled shadows stirred under a thick canopy of wild tamarind and rain trees, but there was no sign of life on the narrow trail stretching out ahead of us.



Without the crunch of their hooves on the dry leaves, the forest seemed eerily quiet.

"I don't hear a thing," he said.

"I don't either, Dara," my mother added. She was sitting in the back of the cart behind us, on a thin layer of straw.

"Well, I heard it," I said. "A bronze cowbell. A big one – probably shiny, too." I could imagine it gleaming in the afternoon sunlight as it swung from the neck of a strong young bull.

Sarun straightened up beside me in the oxcart and reined in the pair of oxen.

"Which direction was it coming from?" Sarun asked. "Can you tell?"

I pointed to the reddish glow of afternoon sunlight filtering through the trees.

"Due west," my brother said thoughtfully, starting the oxen on their way again. "That's where we're headed. Maybe we're getting close to the Border."

"That's what you've been saying for days," I snapped, my hunger making me irritable.

Sarun glanced over at me and tried to smile. "Maybe we'll actually reach it tonight. Then we'll have grilled fish and fresh white rice for dinner. How does that sound?"

"I want something now," I said.

"But you just had breakfast," my mother broke in gently. There was a bit of straw in her hair, and she looked tired and discouraged.

"That was just a handful of cold rice," I protested. "Besides..."

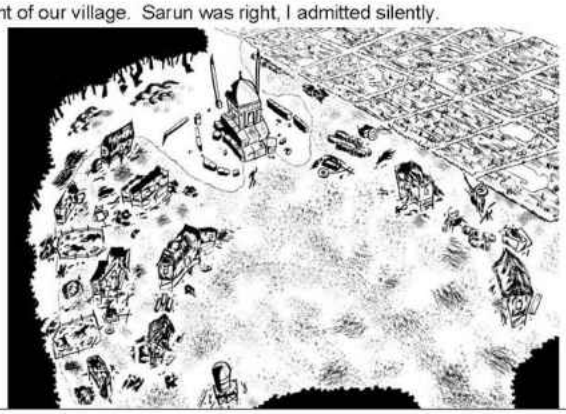
Sarun gave me a warning look. Quiet, it said, don't make Mother any unhapppier.

I remained silent. The only sounds were the rustling of leaves above and the creaking of cartwheels beneath us.

Then my stomach growled. "We would have been better off if we had stayed at home," I mumbled.

Sarun heard me and looked annoyed. "Stayed home? For what?" he asked. "There's nothing there. No food, no seeds, no animals."

I thought of our village. Sarun was right, I admitted silently.



It was just an expanse of dried-up rice fields now, with a crumbling temple and flimsy huts.

In the latest spate of fighting, the Khmer Rouge soldiers had even set fire to our houses and rice barns, so that the invading Vietnamese soldiers wouldn't be able to claim them. But that had left us with nothing to eat, no rice seed with which to plant our next crop of rice, not even a house to live in.

It had not always been like that, though.

I remembered happier times, when I was just two or three years old, and the smiling round-faced Prince Sihanouk ruled Cambodia. Our little village was a peaceful and prosperous place then, the rice fields green and calm, the harvests plentiful. At weddings and on temple feast days, I had sat curled in my mother's warm lap, nibbling at some sticky rice and coconut, sleepily watching the familiar faces of my father and brother, cousins, aunts, and grandparents dancing by the light of a kerosene lamp in the temple courtyard.

But then the fighting and bombing had started. At first the war had been distant and mysterious.

Then the bombing had come closer, so close that the bombs shook the soil beneath my bare feet. My father and other farmers in our village dug trenches where we all hid, crouching, at the sound of the approaching planes. For months, bombs were dropped around us, sometimes as often as five or six times a day, and many of the villagers were killed or hurt by shrapnel.

Tiny silver airplanes, like fishes in the sky, would fly over us before disappearing into the horizon.

Kill the imperialists, they exhorted us, and kick out Prince Sihanouk. But that was like being told to catch evil spirits – so faceless and far away were the pilots in their airplanes and the Prince in his palace.

Yet, remote as they seemed, they must have been defeated, because the bombing stopped. Soon the Communist soldiers took over the village, announcing that they had "liberated" us.

Gaunt young Communist soldiers dressed in black came down from the hills to tell us that it was the American imperialists who were bombing us.

Liberation turned out to be a long nightmare of hunger and misery. And fear – always that cold, silent fear.

My brother and most of the other young men in our village were sent miles away to dig ditches with huge work crews. Most of the women and children were allowed to remain at home, but we had to work much harder than before, and always under the watchful eyes of the armed soldiers. We never got enough to eat, and were sometimes fed only rice gruel and boiled banana stalks at dawn and dusk.

One night my father was roused from his sleep and taken away by two soldiers. We found his body the next day, at the edge of the forest. Had he been killed because he know how to read and write and had taught the village children their alphabet? Or perhaps because he had gone to catch some snails in the fields for my grandmother to eat because she was sick and dying? I will never know. I knew only that I was not allowed to ask about him, or even cry when I missed him.

Over and over again we had been told by the Khmer Rouge soldiers that Cambodia was one big family, and that the Communist Party was our parent. And yet, in trying to create a new "family," the Communists destroyed my own family, ripping apart parent from child, brother from sister, husband from wife. It made no sense to me, since I could not understand how these shrill young soldiers could be my parents, but I did not dare ask.

Three years passed like one long nightmare, the kind where you are gripped by such a cold dread that you are unable to wake up from it.

Finally, shortly after I turned twelve, Vietnamese soldiers in green uniforms marched into our village, sending Pol Pot's Khmer Rouge soldiers on the run, and "liberated" us again. In the confusion, while the two armies were busy fighting each other, Sarun and some other farm boys escaped from their work crew and made their way home.

What a strange reunion that was – so muted and sad.

Father was dead, Mother told Sarun. And Grandmother as well. Describing how other relatives had died or disappeared, Mother started to weep, but Sarun stopped her. "It's not time to grieve yet," he said. "This is our chance to save what's left of our family. The Khmer Rouge butchers are in retreat, and the new Vietnamese-controlled regime doesn't seem to have much power over us yet. We've got to try and put our own lives in order now.

And he told us of his plans to cross overland through western Cambodia to the border between our country and Thailand.

"Thousands of farmers all over Cambodia have made their way there," he told us. "That's our only hope, to go there and stock up on food and rice seed and other supplies. Then we can come home, repair the house, replant our fields, start our lives over again."

He had heard rumors of a refugee camp called Nong Chan, located on the Thai-Cambodian border, where free food and tools were being handed out.

Mother shook her head wearily. "How can we know if the fighting will ever stop?" she asked. "Or if the Khmer Rouge won't win back control of the country? How will we know that we can ever live in peace?"

"We won't know, Mother," Sarun said gently. "But at least we can try."

Quietly my mother looked at the scorched earth around her and then, without another word, dug up her small silver amulet of the Lord Buddha from where she had buried it years ago beside the bamboo grove. Then we hitched up our oxcart and started the long journey westward.

That was nine days ago, and our meager supply of food and our strength were running low. Yet there was still no sign of this Border. Instead, we had caught so many glimpses of fighting and bloodshed on the main roads that we decided to take to the small dirt paths winding through the forests. Sometimes we met other people traveling in small silent groups, on foot or in oxcarts like ours. But beyond exchanging a cautious greeting or some brief directions, no one ever talked to us. Once we met some Vietnamese soldiers on patrol who saw us before we could hide, but they made no attempt to stop us.

By Sarun's calculations, we should have been at this refugee camp at the Border two days ago. I stole a glance at him now. What if he was wrong, and there was no such thing? The thick forest stretched out in front of us quiet and dark. There seemed to be no end to it.

Then I heard it again, the distinct sound of a clear bronze bell in the distance. It was coming closer. I sat up straight and noticed that Sarun had cocked his head toward the sound. So he had heard something, too.

Then I saw it.

"I told you!" I said triumphantly.

Sarun just stared, awestruck.

The bull was pulling a cart heaped high with gunnysacks of rice, with plowshares, with hoe heads, with rope and even fishnets. So heavily laden was the cart that it swayed from side to side as it moved, creaking noisily.

Smooth and polished, the bronze bell flashed in the afternoon sun. It was dangling from the neck of a milk-white Brahman bull, who slowly emerged from the shadows of some teak trees.

As we watched, the wheels of the oxcart slipped into a deep rut and lodged there. The driver stood up in the cart and flicked his whip at the ox, urging it to pull. Nostrils flared, the bull strained at its harness. But it was no use. The cart did not budge.

Sarun jumped down from our oxcart and ran over to the other wagon. Nodding briefly at the driver, he gripped one of the spokes in the stuck wheel and began to push. The other man climbed down and joined him. For some time there was only the sound of grunts as both men applied their weight on either side of the large wooden wheel. Then slowly, inch by inch, they eased it out of the rut, and the cartwheel rolled free.

The stranger wiped the sweat off his forehead with his sleeve. "Thanks, brother," he said.

"It's nothing," Sarun replied. "That's quite a load you have there."

The man laughed. "Everything a person could want," he said.

Sarun circled the cart. There was a small tear in one of the sacks, and he squeezed something out of the slit, onto his hand. I heard him gasp.

"What is it?" I asked.

"Rice seed," he said, his voice soft with wonder.

My heart leaped: rice seed. Rice not just to eat but to grow. Looking at the brown husks cupped in my brother's hand, I felt that we could really go home and plant a good crop after all.

Wordlessly he came over to me and stretched out his hand. Cupped in his palm were some grains of rice, each one still encased in a protective shell of thin, brown husk.

"Where did you get this?" Sarun was asking the other man. "Is there any more?"

"Any more? Brother, is there any more water in the sea? Is there any more soil on the ground?" The man laughed again, a deep, throaty laugh. "There's more rice there than I've ever seen in my life! Husked rice, long rice, short rice, sticky rice, fragrant rice..."

"And rice seed?" Sarun prompted.

"Rice seed? Listen, if they stacked up all the bags of rice seed there, they'd have a pile as high as the cardamom Mountains!"

"And all this was at the Border?" Sarun asked.

"It's not just rice, brother," the other man went on. "Why, they've got enough tools there to build another Angkor Temple, and enough fishnets to catch all the fish in Tonle Sap lake!"

"Tell me where!" Sarun asked, his voice urgent. "Was it at the Border?"

"Of course," the stranger said. "At Nong Chan."

Sarun swallowed hard. "Nong Chan?" he repeated. I could see the lump in his throat bob up, then down. "It's true, then? Those rumors of free food and supplies at the refugee camp. It's all true?" It was not really a questions but a plea.

I realized then that despite my brother's assurances to us, he must have had his doubts all along.

The stranger sensed the tension in Sarun and grew serious. "If I laughed too much just now," he said, "it was not because I was joking. No, it's just that the happiness keeps jumping out of my throat. Yes, brother, it's all true, what they say about the Border."

"And there's more there? For free?"

"Just stand in line, and they practically throw things at you," the man said, and laughed again.

Behind me, I saw my mother bow her head over her silver amulet and pray. "Thanks be to the Lord Buddha," she whispered.

And although for the past three years I had not prayed, so that now I could barely remember the words with which to speak to the Buddha, I bent my head and gave thanks, too.

On an impulse, I decided that I wanted to sleep under the open sky. So I spread my mat alongside the cart and stretched out on it.

The stars were just beginning to shine, and a cool evening breeze stirred the still air. In the distance, I heard a mother singing a lullaby. It had a familiar melody, one that I could remember my mother singing to me long ago. The pulsing hum of night sounds, of crickets and cicadas, settled over me like a light blanket.

As I shut my eyes, I took a deep breath. I had the strange feeling that somehow I had finally come back home.

Close by, the cooking fire was burning low, and a few sparks still whirled away into the night sky. Elsewhere, a boy was whittling a stick of firewood, and a baby was whimpering as its mother crooned to it.

Chapter 2

It seemed as if all the paths out of Cambodia were converging on this one spot on the Thai border.

I could barely contain my excitement. I imagined mountains of rice lining the horizon, and piles of tools and fishnets everywhere. Perhaps there would even be mounds of sweet moist coconut cakes and banana fritters. "Hurry," I urged my brother.

The last rays of afternoon sun were filtering through the forest as we approached the Border. Gradually the trees thinned out and the path widened. Several trails merged into ours.

Yet, as we finally emerged from the forest, all we could see was a vast barren plain dotted with shrubs and scraggly trees, flat and desolate. Overgrown clumps of fireweed and red sorrel stuck out from patches of buffalo clover, and then even those gave way to the cracked, hard soil of paddy fields in the dry season.

As we drove farther through the scrubland, though, I noticed that there were signs of life in the distance, of people and oxcarts so far away that at first they looked like black specks. Sarun urged our oxen on, and soon we could see more evidence of human activity. The branches of the few trees around had been chopped bare for firewood, mudholes had been dug for buffaloes to wallow in, and makeshift fences had been built around small vegetable gardens. We drove past these and approached the fringe of the refugee camp itself.

It looked like an endless brown sea of thatched lean-tos, mingled with bright blue patches from clusters of plastic tens. Spirals of smoke from countless cooking fires broke up the vast flatness of the landscape.

Why did it look so familiar and yet so unusual?

And it suddenly struck me: everyone was part of some family – not the cold-blooded Khmer Rouge version, the state as family, but a living, laughing, loving family.

I looked around in wonder. Even though many people seemed to be only fragments of a family – a frail grandmother with several young toddlers, or a group of young boys clustered around a few old men – they were a family just the same. Like a patchwork blanket, I thought, the people here were survivors of families who had been ripped apart and then joined again.

We passed women taking down laundry from lines, children spinning tops near the makeshift shelters, and quiet groups of people sitting around chatting.

And everyone seemed to be busy doing something. Not just sitting alone silent and hollow-eyed with hunger, or organized into huge groups digging endless ditches. No, the people here were preoccupied with countless different chores of their own.

I saw a sinewy old man splitting firewood; children lining up to draw buckets of water from a well; boys scrubbing their buffaloes in a shallow mudhole nearby; sisters combing each other's hair.

And because it was getting close to dinnertime, there were women cooking everywhere. I could smell rice steaming, salted fish sizzling in hot oil spiced with chili, peanuts roasting – I even thought I caught a whiff of coconut cakes!

"It's like coming home," Mother said, with quiet wonder.

I knew exactly what she meant. Nong Chan was a strange place unlike anything we had ever seen before, a vast barren field teeming with refugees. But in the bustling quiet of dusk, it had the feel of our village during the years of peace before the fighting had started, when farmers would come in from the fields as their wives fanned the charcoal fires and their children bathed with fresh well water.

Driving our oxcart, Sarun maneuvered the oxen through the scattered campsites until it became too crowded for the animals to move easily. He jumped down and led the oxen by the reins, threading his way carefully among the families.

Several clusters of people were already settled there, with their thatched lean-tos and small fires, but nearby there was some empty space that no family had staked out for its own yet.

He headed for a well near a forked tree, where there was also a shallow creek in which buffaloes were wallowing.

"This looks like a good spot," Sarun said, turning to Mother. "It's only going to get more crowded farther in."

Mother nodded, and together we got off the cart and started to unload our few belongings while Sarun unhitched the oxen.

"Poor things, you've both earned a rest," he murmured to them, patting the animals' thin flanks as he led them off to the water hole nearby.

Mother looked around for a place to set down her kettle and sleeping mat.

A girl spoke up. "Put your things over here, if you like." She was kneeling, stirring a pot of bubbling rice, and smiling up at us.

Mother set down the kettle she was holding, and I helped her put her sleeping mat beside it.

"Welcome to Nong Chan," the girl said. She looked about Sarun's age, eighteen or nineteen, and had a broad face with high cheekbones.

"Where do you come from?" she asked.

"Siem Reap," Mother answered.

"Really?" The girl brightened. "So do we! Our village is right next to the lake."

There was a bright checkered kerchief wrapped around her hair, and her eyes were friendly and curious.

"That makes us practically neighbors," Mother said, squatting down companionably beside the girl. "How many of you have come over to the Border?"

"There's four of us: my grandfather and my two little cousins," the girl said.

"And your parents?"

"Dead," the girl said simply. "As are my sisters, and the parents of the cousins with us." She gave the pot of rice a quick stir. "My grandmother and three brothers, too. All dead."

"My husband died four years ago, and then my mother," Mother said.

For a moment there was silence. I had heard enough of such conversations not to interrupt. First there were the greetings, then the terse tally of the dead, then the pause. Only after that, it seemed, could there be talk of other things.

The girl fanned the cooking fire before dipping a twig into it. "Let me help you get your fire started," she said. "It's getting late, and you must be very hungry." She extended the glowing twig to my mother.

Mother looked at the twig, but made no move to accept it. "There's really no need," she said awkwardly. "We really…I mean, we don't…" We don't have any more rice to cook, I knew she wanted to say, except that she couldn't bring herself to admit it.

"Of course!" the girl exclaimed. "You don't have any firewood. How could you have gathered any? You just got here. Kindling is getting scarce, I can tell you. Most of the trees have been stripped bare – even the roots have been dug up for firewood. Here." She shoved a bundle of kindling toward Mother. "Use this for your fire."

Mother bit her lips. "No," she said, almost curtly. "You keep it."

The girl frowned, then her expression cleared. "Grandpa says my tongue's quicker than a raging river, but my mind is as thick as mud!" Using a tin cup, she scooped rice out of a gunnysack and stirred the grains into the pot already on the fire. "It's a good thing I just started cooking," she said cheerfully. "Won't have to start another pot. I'll just add some more water, and we'll have enough for all of us. There!" She looked up at me and my mother. "You will join us for dinner," she said. It wasn't a question, or even an invitation, but a simple statement.

"No, it's all right," my mother said stiffly. "We're not hungry."

The girl reached out and put her hand on Mother's arm. "You don't understand," she said gently. "It's different here. We have enough to eat. We have more than enough."

Then she must have seen the tears brimming over in Mother's eyes, because she turned away and started to stir the rice vigorously.

Before long the girl had Mother peeling a clove of garlic and crushing dried red peppers. I could tell that my mother was enjoying cooking again, now that there was seasoning and even some salted dried fish to work with.

Next the girl turned her attention to me. "I'm going to bathe while the rice is cooking," she said. "Want to come along, little sister?"

I hesitated.

"Not shy, are you? My name's Nea. What's yours?"

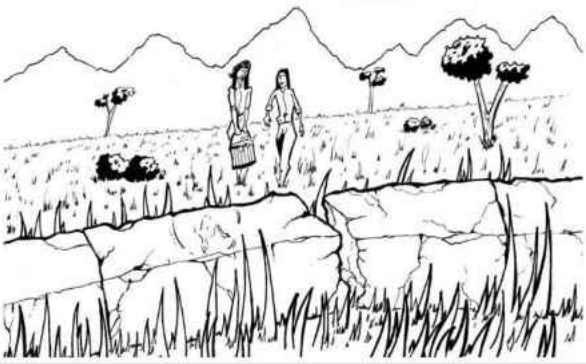
"Dara."

Well, come on, Dara. I've got a bucket of clean well water here we could share."

There was nothing I would have liked more than to douse myself with cool water just then, but I could see no hedge, no mud-brick wall, not even a line of laundry, to bathe behind.

Nea must have sensed my shyness, because she laughed as she tugged at me. "You've got to do everything out in the open here," she said cheerfully. "Come on, it's easy once you get used to it."

I followed Nea as she carried her pail of water to a massive beam of solid stone half-sunken in the fields. "My grandfather says that it might have been the crossbeam over the gateway of an ancient temple during the Angkor Empire," Nea said, pointing to the stone. "If so, it'd be almost a thousand years old."



I looked at the stone beam curiously. Chiseled on it were some whorled markings, worn smooth with time. On one corner of it was a carving of what must have been an *apsara*, a dancing angel. But all that remained now was a delicate hand, its stone fingers arching gracefully back as if in the middle of a dance.

Gently I touched one fingertip, and felt as if I had reached across a thousand years.

"How did it get here?" I asked.

"Grandpa Kem isn't sure. Maybe it was the spoils of war, taken from some famous faraway temple like Angkor, or maybe there are some small ruins nearby that nobody even knows about."

Then, without even looking around, Nea hitched her sarong up to her breasts and deftly stripped off her shirt. Scooping some water out of her bucket with a dipper, she splashed the water over her bare shoulders.

"Come on," she called, sprinkling some on me.

How wonderfully cool the drops of water felt. Clumsily I wrapped my sarong around my chest, too. Just as well I'm still flat-chested, I thought, as I wriggled out of my shirt.

Together, taking turns with the dipper, we bathed out in the open. I scooped ladle after ladle of water over myself, feeling the cold seeping through my scalp and down my shoulders. After those long, dusty days in the creaky oxcart, it felt so refreshing that I laughed out loud, and Nea laughed along with me.

When we had used up all the water, we walked back toward the carts, swinging the empty pail between us. As we approached the cooking fire, Mother looked up at us and smiled. I felt as if someone had suddenly reached inside me and squeezed my heart, so strong and happy was my mother's smile. I couldn't remember when I'd last seen her smile like that.

"Dinner's ready," Mother announced, pointing to a dish of salted fish stir-fried in garlic, and the pot of steaming rice. "Hope I didn't make it too spicy."

I started to head for the food, but felt Nea tugging at the pail.

"Come on," she was saying nervously. "Let's get into some dry clothes."

Only then did I notice that my brother was nearby, and staring open-mouthed at us. Not at me, I realized, just at Nea. I looked at my new friend. Beads of water glistened on her bare shoulders, and her wet sarong clung to her. I felt annoyed at my brother for staring like that, but one look at him, and I relented. All those years Sarun had spent digging ditches, I though, he'd probably never seen a girl as lovely as Nea. Or as wet.

By the time I had changed into dry clothes, and joined my mother and brother by the cooking fire, an old man and two children were also sitting there. Mother edged closer to Sarun to make room for me, so that the three of us formed a semicircle around the flames.

Nea started ladling out the rice, and as she did so, she introduced the old man next to her, a tall gruff man with thick eyebrows. This is Bou Kem, my grandfather," she said.

I nodded at him shyly.

"What do you say?" Mother prompted me.

"Grandpa Kem," I said obediently, and Mother nodded her approval.

On her other side, Nea explained, were her two cousins. One was a girl about my own age, and the other was a plump baby. I barely nodded to each of them before turning my attention to the rice.

Nea handed the first plateful to her grandfather, who took it without comment. She passed the next plate to my mother, who hesitated, then thanked her softly. Sarun was next. When Nea stretched out her hands to offer him a plate, he would not take it.

"Sarun, come on," I whispered.

He pretended not to hear me, and kept stoking the fire, sending a few sparks spinning up into the air. Torn between his hunger and his pride, Sarun couldn't seem to decide whether to accept or refuse Nea's offering.

"Please eat something, brother," Nea said softly, smiling at him across the fire. "It has been a long hard trip, and you need to keep your strength up."

He looked up at her, and finally he held out his hands and accepted the plate of rice from her.

My turn was next, and I almost snatched the plate from Nea. The fragrance of the long-grained rice was wonderful. Steamy and sweet and warm, it wafted up to me. I had not seen such a generous mound of white rice for a long, long time.

I lifted a spoonful of rice and ate it. I thought about what a wonderful thing it is to eat rice. First you let the smell drift up in lazy spirals, sweet and elusive; then you look at the color of it, softer and whiter than the surrounding steam. Carefully you put a spoonful of it in your mouth, and feel each grain separate on your tongue, firm and warm. Then you taste it – the rich yet delicate sweetness of it. How different it was from that gritty red rice we'd been rationed to, the last three years, gruel so bland and watery that it slipped right down your throat before you could even taste it. No, this was real rice, whole moist grains I could chew and savor.

I thought I was slowly relishing each mouthful, but before I knew it, my plate was empty. My mother had already started her second plateful, and Sarun was finishing off his third. None of my family had even bothered to try the fish in garlic sauce, we were enjoying the plain rice so much. I wondered if we were being too greedy. But Nea had noticed my empty plate and was already reaching over to ladle more rice on it.

"What about you?" Mother asked, glancing at the rest of Nea's family. "Will there be enough?"

"There's more than enough." Nea smiled. "That's what makes the rice taste so sweet here, don't you think?"

Nobody else said anything much, and soon we were all done eating. Mother went off with Nea's young cousin to rinse off the plates at the well, while Sarun stayed by the fire to talk to Nea and her grandfather.

I strolled back to our oxcart and shook out my sleeping mat. Ever since we'd set out on this trip, I had slept under the broad wooden planks of the cart. In the unfamiliar darkness of the forest, it had been comforting to have those planks as a shelter. But I hesitated now, standing with my mat between the cartwheels.

APPENDIX H: IRB NOT HUMAN RESEARCH DETERMINATION

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2012 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

NOT HUMAN RESEARCH DETERMINATION

From : **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To : **Jamie O'Neal**

Date : **December 02, 2009**

Dear Researcher:

On 12/2/2009, the IRB determined that the following proposed activity is not human research as defined by DHHS regulations at 45 CFR 46 or FDA regulations at 21 CFR 50/56:

Type of Review:	Initial Review
Project Title:	A Study of Multi-Modal Reading to Improve Vocabulary Acquisition and Comprehension in Level 1 Readers
Investigator:	Jamie O'Neal
IRB ID:	SBE-09-06577

University of Central Florida IRB review and approval is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are to be made and there are questions about whether these activities are research involving human subjects, please contact the IRB office to discuss the proposed changes.

On behalf of the IRB Chair, Joseph Bielitzki, DVM, this letter is signed by:

Signature applied by Janice Turchin on 12/02/2009 11:35:55 AM EST

IRB Coordinator

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