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Multimedia Technologies' Influence on Language Acquisition in English Language Learners

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Walden University
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MPh, University of Puerto Rico, Medical Science Campus, 1999

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

English as a Second Language (ESL) learners at the upper elementary level have struggled to demonstrate the vocabulary required to read in English at grade-level. Although multimedia technologies have demonstrated positive effects as language acquisition educational tools at the university level, it remains unclear how useful they are for language acquisition at the elementary level. This quasi-experimental study used dual coding theory as a framework to examine the relationship between the level of reading comprehension upper elementary students developed and their construction of word meanings through use of multimedia technologies. The study utilized convenience sampling of 85 students divided into treatment and control groups in a Puerto Rican Montessori school. The treatment consisted of use of multimedia technologies that included video, audio, images, and words in a digital environment for vocabulary acquisition instruction. Data sources included pretest and posttest results for the Maze Close test that measures reading comprehension. These results were analyzed using a paired *t* test. Results indicated that students in treatment groups developed greater reading comprehension than did those in control groups. However, the difference in scores between the groups was not significant, so the null hypothesis was not rejected. Further research is required in order to determine whether a positive relationship can exist between multimedia technology usage and development of upper elementary student vocabulary and reading comprehension. This study indicates the importance of examining whether multimedia technology use in elementary student English reading comprehension can create reading gains for upper elementary ESL students.

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Dedication

This work is dedicated to my family. To my father, who always encouraged me to keep going and passed away while I was on the journey to this dissertation. To my mother, who supported me in completing this work. To my 15-year old daughter, who had to wait many times for me to answer her because I was writing or conducting research for my dissertation. Without your support and encouragement, I could not have accomplished my dissertation. Thank you for all you have done.

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Chapter 1: Introduction to the Study

Learning to read and comprehend what is being read is a predictor of future socioeconomic progress. For the Hispanic population in the United States, developing English literacy is critical to economic progress and to increasing individuals' potential contributions to society. The U.S. National Assessment of Educational Progress (2007) reported that the number of school-aged children (ages 5–17) who spoke a language other than English at home increased from 4.7 to 11.2 million between 1980 and 2009. In addition, in 2009, about 21% of children ages 5–17 (or 11.2 million) spoke a language other than English at home, and 5% (or 2.7 million) spoke English with difficulty. Seventy-three percent of children who spoke English with difficulty spoke Spanish (National Assessment of Educational Progress, 2007). Puerto Rico is a U.S. territory whose official languages are English and Spanish. Learning to read proficiently in both languages results in better employment and professional development opportunities.

Two of the most influential factors in learning a second language are school instruction and exposure to the language (Biemiller, 2003). However, learning to read any language is a complex process that depends initially on multiple decoding skills. Once children are able to master decoding skills, the influence of other variables in the reading progress is more noticeable. Eventually, the development of reading understanding depends on breadth of vocabulary and vocabulary skills in a direct proportional relationship (Becker, 1977; Chall & Conard, 1991; Chall, Jacobs, & Baldwin, 1990; Francis, Lesaux, & August, 2008; Lesaux & Kieffer, 2010; National Institute for Literacy, 2001; Silverman & Crandall, 2010; Snowling & Hulme, 2011).

During the early stages of development, vocabulary learning depends mostly on oral communication skills, which are developed primarily at home (Lesaux, Kieffer, Faller, & Kelley, 2010). Therefore, in contexts where children's only contact with the second language occurs within school educational programs targeting their language development, exposure, and enrichment are essential. This study contributes to the set of current language programs designed to facilitate ESL children's acquisition of the English language. This chapter presents a detailed explanation of the research problem as well as the study intent, variables to be measured, and theoretical framework supporting the design. In addition, the chapter contains a general snapshot of current research in the areas of interest related to the study and the possible limitations and challenges.

Background

Due to Puerto Rican children's lack of exposure to English at home, special educational programs considering this population need to be implemented to target oral communication skills and vocabulary acquisition. Those charged with the development of such programs need to ponder children's culture (Stahl, 2003); word frequency (Miller & Roodenrys, 2012); breadth versus depth of vocabulary (Proctor, Uccelli, Dalton, & Snow, 2009); and concreteness and contextual richness (Gutierrez, 2010; Lesaux, Geva, Koda, Siegel, & Shanahan, 2008; Sadoski, 2005). In addition, vocabulary learning can be increased by enriched educational environments, which can allow children to be exposed to multiple forms of vocabulary interaction (Chai & Erlam, 2008; Cohen & Johnson, 2010; Farley, Ramonda, & Liu, 2012; Mayer & Moreno, 2003; Rosen, Fullwood, & Henley, 2012; Schwartz, 2005; Silverman & Hines, 2009).

The Montessori pedagogy is based on the active involvement of the child in the learning process (Lillard, 1996; Montessori, 1966). In a Montessori classroom, children learn by exploration. This environment is explored through the development of the senses. Subsequently, throughout their years in lower and upper elementary Montessori schools, children interact with a variety of materials that allow them to develop skills and knowledge, as well as strengthen their self-esteem (Lillard, 1996). This pedagogy invites the child to constantly learn by multiple channels. For example, language is integrated into the whole curriculum and is worked through the use of illustrations or physical objects of what is being read. The Montessori method supports the use of pedagogical tools that help to stimulate different areas of the brain. This goes hand in hand with dual coding theory, which indicates that human beings have the ability to store information both verbally and nonverbally (Paivio, 1991).

Furthermore, according to this theory, people can create connections between verbal and nonverbal memories, which allow them to have additional resources to access and retrieve stored information (Paivio, 1991). This theory supports the use of multimedia technologies to present the student with information resources that integrate verbal and nonverbal stimulation. Nonverbal elements may include an image, a sound, a smell, or a sensation. Multimedia technologies enable the use of images and sounds to learn vocabulary. For instance, the verbal word can be associated with an image, an animated action, a sound, or a combination of images, sounds, and text. This association allows the child to have multiple references to the word, thus increasing his or her short- and long-term word-learning capacity (Farley et al., 2012). Nonetheless, it is important to

consider that the degree of effectiveness in the use of multimedia technologies depends primarily on the level of cognitive overload learners can experience when they are exposed to a combination of elements that stimulate both memory channels. One of the media components (verbal or nonverbal) could distract or divide the learner's attention, provoking a memory overload and a decrease in learning achievement (Mayer & Moreno, 1998, 2003).

The veracity of the dual coding theory has been widely proven through the use of multimedia technologies (Chai & Erlam, 2008; Cohen & Johnson, 2010; Farley et al., 2012; Mayer & Moreno, 2003; Rosen et al., 2012; Schwartz, 2005; Silverman & Hines, 2009), yet the majority of these studies have been conducted on college students. Little has been done to explore the use of multimedia to increase vocabulary acquisition in Montessori upper elementary schools for ESL learners. In addition, it is important to note that in all of the studies reviewed for this dissertation that involved the use of multimedia technologies for knowledge acquisition, the student was passively receiving the information. The student's interaction with the multimedia technology was limited to setting the media pace; the student did not necessarily engage actively in the learning process.

Correspondingly, vocabulary acquisition processes have been studied from different approaches with English native (L1) speakers and ESL children (Duesbery, & Alonzo, 2005; Mancilla-Martinez & Lesaux, 2010; Lesaux, Crosson, Kieffer, & Pierce, 2010; Riedel, 2007; Yovanoff, Schilling, Carlisle, Scott, & Zeng, 2007). The majority of research conducted on ESL learning in children has focused on the early elementary

grades. During the early elementary years, reading decoding skills present the greatest challenge to students, along with oral communication skills. *Decoding skill* refers to the ability to connect characters to oral sounds when reading. Research has been conducted to explore the impact of interventions that address the development of oral communication and decoding skills. The intention of these interventions has been to study reading comprehension at the upper elementary level (Baker, Stoolmiller, Good III, & Baker, 2011; Brice & Brice, 2009; Kieffer, Biancarosa, & Mancilla-Martinez, 2013; Kim, 2012; Yopp & Stapleton, 2008). These studies have demonstrated the critical role decoding skills play in learning to read and eventually understanding what is being read. However, these studies also point out that in upper elementary, reading comprehension becomes a major challenge for multiple reasons, including increased complexity of class text materials and lack of vocabulary knowledge. It remains necessary to demonstrate to what extent interactive multimedia technologies can reinforce the vocabulary acquisition process for upper elementary ESL children over the short and long term. Detailed discussion of this matter is presented in Chapter 2 of this dissertation.

This study contributes to the literature by establishing pedagogical methods that combine technology dynamically and proactively with the vocabulary learning process. These methods can be easily adopted by teachers and effectively implemented in upper elementary classrooms with ESL children.

Problem Statement

Although multimedia technologies have proven to be effective educational tools for language and information acquisition, most of the studies in this area have been

conducted at the university level and have required a passive role for the student. There is a need for increased understanding of the contribution of multimedia technologies to the process of language acquisition in ESL children at the upper elementary level. A review of the literature revealed that there is little evidence of the effect multimedia technology use might have in the acquisition of vocabulary over the short and long term. Furthermore, the literature fails to address whether an active role while using this technology might increase the learning results and ultimately increase reading comprehension.

Purpose of the Study

The purpose of this quantitative study was to explore the contribution that the active use of multimedia technologies can have to vocabulary acquisition and subsequently reading comprehension in children from fourth through sixth grade who are learning English as a second language. The study evaluated the effect of the intervention through quantitative data collection. Statistical tests measured reading comprehension before and after a multimedia vocabulary teaching intervention.

Research Questions and Hypotheses

- RQ1: Can the use of interactive multimedia technology (integration of picture, audio, and text in a digital environment) by ESL upper elementary children increase deep processing of new vocabulary (measured by application of new vocabulary in multiple contexts)?

- Null Hypothesis to RQ1: Interactive multimedia technologies will have no significant effect on ESL upper elementary children's deep processing of new vocabulary when compared with their current classroom learning practices.
- Alternate Hypothesis to RQ1: ESL upper elementary children's use of interactive multimedia technologies will result in an increase of deep processing of new vocabulary when compared with current classroom learning practices.
- RQ2: Can ESL upper elementary children's active interactions with multimedia technologies for vocabulary learning contribute to increasing their reading comprehension capacity?
- Null Hypothesis to RQ2: ESL upper elementary children's active interactions with multimedia technologies for vocabulary learning will have no statistically significant contribution to increasing their reading comprehension capacity.
- Alternative Hypothesis to RQ2: ESL upper elementary children's active interactions with multimedia technologies to learn vocabulary will have a statistically significant contribution to increasing their reading comprehension capacity when compared with their current classroom learning practices.

Theoretical Foundation

In Montessori pedagogy, teachers present materials or learning activities, offering a gift to students. This gift is initial and fundamental knowledge given to them to awaken their inquiring and deeper exploration of information. Through active interaction between

the material and the student, the latter can discover and deepen the basic knowledge that was initially presented. That is why, in Montessori learning environments, students are observed working constantly and actively with their five senses, which work together to maximize the child's learning process. Therefore, in Montessori education, the learning process is interactive, inquisitive, and pertinent. This allows constant cultivation of intrinsically motivating agents permitting the child to experience a pleasant, cheerful, and natural education. Montessori recognized the importance of actively using the senses to maximize learning, and the materials she designed for the elementary school curriculum reflected this conviction (Montessori, 1965). Subsequently, significant developments in the field of neuroscience arose to validate her ideas. One such theory is the dual coding Paivio (1991) developed. This theory originates from the premise that human beings learn by the systematic activation of short-term memory and long-term memory, as well as access and modification of schemes in the latter (Lohr & Gall, 2008). Paivio delved into this idea by specifying that information can be stored verbally and nonverbally. In addition, according to Paivio, there can be interaction between both memories either to store or to access information. This system of storage and access of information has fundamental performance characteristics that need to be considered when designing instructional practices. The details of these characteristics are presented and discussed in Chapter 2 of this dissertation.

Multimedia technologies support the application of the dual coding theory because they allow the presentation of information in multiple forms simultaneously (Mayer & Moreno, 2003). Learning with the use of multimedia technologies allows the

user to dynamically interact with content and design. For this reason, multimedia has been considered a facilitating tool of language learning (Chai & Erlam, 2008; Cohen & Johnson, 2010; Farley et al., 2012; Mayer & Moreno, 2003; Silverman & Hines, 2009). Unfortunately, studies were multimedia has been considered facilitating tools of language learning were performed on college students who were passively involved in the process. Any application must consider the possibility of cognitive overload, which can occur if the design is not well balanced for the user. In Chapter 2 of this dissertation, I discuss various ways in which media technologies have been used for learning a second language.

Being able to understand what is read is a significant component of learning English as a second language. Vocabulary acquisition and reading comprehension are intertwined processes that require significantly more attention at the upper elementary level. An increase in vocabulary acquisition has a positive effect on reading comprehension, which will be translated into facilitating new vocabulary acquisition. That is why vocabulary learning programs for both native English (L1) learners and ESL learners have been developed extensively. Many of these programs target vocabulary knowledge, words with highly academic utility, word learning strategies, and multiple word exposure (Lesaux et al., 2010). Montessori active learning environments might help foster the integration of multimedia technologies that, based on dual coding theory, facilitate vocabulary learning and consequently enhance reading comprehension ability.

Nature of the Study

This was a pretest-posttest control-group study designed to determine the relationship between the reading comprehension performances of ESL children from fourth to sixth grade after their participation in an intervention to help them learn English-language vocabulary. The independent variable in this study was a multimedia vocabulary intervention program. The intervention consisted of weekly preselected readings and multimedia vocabulary activities developed to increase children's knowledge of the words being learned. The dependent variable was children's reading comprehension capacity measured before and after children's completion of the intervention program. A comparison group was included as part of the study and received regular teaching strategies for learning vocabulary. Furthermore, the assignment of subjects to each group was random, and the intervention vocabulary program was applied only to the treatment group (Campbell & Stanley, 1963). At the end of the 8-week intervention program, reading comprehension capacity was assessed. This design allowed the control of internal validity factors such as maturation, age, home income, previous English background, gender, teacher style, and ethnicity group.

Definitions

Literacy: A person's capacity for reading and writing. It is influenced by multiple factors, such as educational background, culture, environment, and social context (Snow, 1998).

Reading: "The use of the products and principles of the writing system to get at the meaning of a written text" (Snow, 1998, p. 42).

Reading comprehension: The capacity to understand words' meaning in context and to make inferences from text (Snow, 1998).

Decoding skills: "The aspect of the reading process that involves deriving a pronunciation for a printed sequence of letters based on knowledge of spelling-sound correspondences" (Snow, 1998, p. 52)

Oral communication skills: The abilities to use language (vocabulary, grammar, and comprehension) to communicate orally with others.

Common underlying proficiency model: Language-learning model that supports the existence of a rapid transfer of acquired skills from one language to another (Gutierrez, 2010).

English as a second language (ESL) learners: Language learners whose primary language is not English.

Montessori pedagogy: A child-centered educational methodology based on the cognitive and physical developmental needs of the child.

Dual-code theory: A memory and processing theory that indicates that information can be stored in different forms, verbal and nonverbal (Paivio, 1991).

Multimedia technologies: Tools that allow the combination of video and sound in digital environments.

Cognitive overload: Refers to the event where the cognitive capacity of the person is exceeded.

Assumptions

The study was designed to develop pedagogical methodologies that English teachers can use to help their upper elementary ESL students learn English vocabulary and acquire skills for future experiences of continual learning. It was assumed that methodologies using multimedia technologies are available to public school children in Puerto Rico and that, independently of the school philosophy (i.e., Montessori or not), they can be implemented. In Montessori schools, children have the freedom to choose when to work in their follow ups. I assumed that this freedom would not interfere with the tasks they had for their English class. I assumed for this study that participants were ESL learners from low economic backgrounds. Children in the study were between 9 and 12 years of age. They had received some form of English language education in the lower elementary grades. Therefore, it was assumed that these children had achieved decoding skills properly.

Scope and Delimitation

This study addressed the acquisition of English vocabulary and vocabulary-learning skills in upper elementary children whose first language was Spanish. In assessing children's reading comprehension capacity, vocabulary acquisition was measured. Long-term language retention was not evaluated in this study. The selected school was public and had adopted the Montessori methodology for the past 13 years. The intervention impacted half of the children from fourth grade to sixth grade. The difference between English levels was in the complexity of the vocabulary selected. The

students' English teacher performed the intervention. These delimitations were an attempt to control the study of extraneous variables that might affect its internal validity.

In Montessori schools, children are accustomed to active learning. They can use concrete materials and more than one tool to learn. Although children have some compulsory tasks to complete, they have the freedom to choose when to work on them, and in multiple situations they can approach the same task differently. For example, in order to learn the multiplication tables, Montessori children have more than five different concrete materials. They can choose which one they are going to use; however, all of them target the same skill. Furthermore, children in this study did not regularly speak English at home or outside of their school. Traditionally, in most public schools in Puerto Rico, English class lasts between 45 to 60 minutes. Therefore, oral language skills, which can be developed through outside-school interaction or during school activities, are not addressed or stimulated. Oral communication influences language acquisition and is important in the development of reading comprehension skills.

Regardless of the scope and delimitations of this study, it can be implemented in any educational context because it is based on learning principles that can be applied to any population. The act of learning through meaningful activities that stimulate multiple paths to store information is universal. Some variables might increase or decrease the outcomes of these activities, but positive achievements can be reached anyway.

Limitation

The school selected for this study was the only public Montessori school in Puerto Rico, with more than 5 years of implementation of this philosophy of education

exclusively. Therefore, students were taught in small groups of no more than eight per level, and because Montessori education is multilevel, they could interact with older and younger children in the same classroom environment. In addition, Montessori classrooms have one teacher and one assistant. This allows teachers to have individualized contact with students. Additionally, special education students do not leave the classroom; instead, the special aid teacher comes to their classrooms to assist them. The setting of this study did not reflect the average class size or public school environment in Puerto Rico. Typically, public school classrooms in Puerto Rico consist of 25 to 30 children, divided by age and guided by one teacher. Students from the special education program are sometimes assigned to self-contained classrooms outside the regular track. The characteristics of this study limit the possible generalizability of its results, thus reducing its external validity. In addition, class sizes might limit the quantity of students participating on each grade level. Sample size was a limitation of the study. Small sample sizes reduce the likelihood of representing the population and significantly reduce the level of statistical significance (Ravid, 2010).

Significance

Educational technology addresses ways in which technology can be used to impact learning positively. Technologies that allow a user to communicate, interact, and create multisensory experiences have evolved significantly over the past years. This study presented an opportunity to use multimedia technologies that may be accessed free of charge to increase learning opportunities for minority children learning English as a second language. The independent practices explored through this study may contribute

to knowledge of effective learning practices in upper elementary classrooms to help students acquire English vocabulary and may facilitate their reading-comprehension experiences. Studies such as this one may contribute to the reduction of current technology gaps by demonstrating the diversity of opportunities presented to English language learners through the use of multimedia technologies. By supporting the implementation of better technology practices in schools, it may be possible to pave the way to an education that enables students to deepen their knowledge.

The highest dropout rate in Puerto Rico is observed in secondary schools (Disdier, 2012). The complexity of materials and knowledge increases significantly at the middle and high school levels. Children who carry language gaps will confront additional disadvantages for learning, and eventually school may become unbearable for them. Increasing their language knowledge and giving them tools to learn more in the future may positively contribute to the effort to prevent kids from dropping out of school.

Summary

This study presented an opportunity to explore multimedia technology usage in learning vocabulary and increasing reading comprehension in upper elementary ESL learners. Using multiple sensory representations during active interaction with technology, children were expected to meaningfully interrelate with vocabulary to understand it more deeply and apply it in further reading comprehension experiences. This chapter has presented a general overview of the study design, implementation scope, theoretical background, and current knowledge about the main topics related to the intervention.

A literature review is presented in Chapter 2 on current research findings on ESL learners and multimedia technologies. This chapter also presents the ground on which the design and implementation of this study rested.

Chapter 3 describes the methodology used to study the research questions. This chapter addresses analysis of covariance as a statistical approach to the analysis of pretest-posttest research design. Chapter 4 presents the results of the study, and Chapter 5 presents the interpretation of the results, implications for social change, recommendations for action, and recommendations for future research.

Chapter 2: Literature Review

Introduction

Even though Puerto Rico became a colonial possession of the United States in 1898, the primary language of the island's inhabitants is Spanish. Due to Puerto Rico's political relationship with the U.S. government and the historical changes in its government, English is taught as a second language. The common educational tendency in Puerto Rico is for students to receive a 40- to 55-minute daily English class from kindergarten to 12th grade. The local government and the public school system have recognized the acquisition of the English language as beneficial for the future professional development of the population and for ensuring improved opportunities for migrants to the U.S. (National Institute for Curriculum Development, 2003).

Although learning English is highly valued in Puerto Rico, children's first encounter with English occurs through the school system. This presents a disadvantage for ESL children, given that for native speakers, oral communication skills begin developing from birth in family environments and through peer interactions. In Puerto Rico, the language predominantly spoken at home and in the rest of the immediate environment is Spanish. The U.S. Census Bureau (2009) has estimated that 95%of the island population speaks a language other than English at home and that 82% speaks English less than "very well." In addition, according to the U.S. Census Bureau (2009), 20% of the U.S. population aged 5 and over speaks a language other than English at home. Of this 20%, 76% are classified as Hispanic (U.S. Census Bureau, 2009). These numbers have increased steadily since 1980 (National Assessment of Educational

Progress, 2007). The National Assessment of Educational Progress (2007) reported that the number of school-aged children (children ages 5–17) who spoke a language other than English at home increased from 4.7 to 11.2 million between 1980 and 2009. Likewise, in 2009, about 21% of children aged 5–17 (or 11.2 million) spoke a language other than English at home, and 5% (or 2.7 million) spoke English with difficulty. Seventy-three percent of children who spoke English with difficulty spoke Spanish.

The reality these numbers represent has a direct effect on the school system. Curriculum modification and remediation programs have been developed in order to support the inclusion of this population in the educational system with equal opportunities for their success and future wellbeing. In 2009-2010, the total number of public school students in the United States was 48.0 million. The National Assessment of Educational Progress (2007) estimated that 4.7 million students (10%) of public school students were ESL learners. The integration and assurance of equal opportunities of this population for work, prosperity, education, and health, among other things, is highly influenced by literacy achievements (U.S. National Reading Panel, 2000). Consequently, every effort in the development of educational practices that helps to improve English reading skills has significant value.

The learner's interaction with meaningful activities and knowledge, along with an empathic learning environment, is essential to the process of learning a second language (Adamson, 2005). In Montessori pedagogy, education is child centered. It is the child, through his or her interactions with the environment and use of materials intentionally placed in the classroom, who will develop his or her internal potential (Montessori,

2007). Montessori pedagogy and dual coding theory, together with multimedia technologies, can provide meaningful and effective conditions to ensure an approach that helps ESL learners improve their reading capacities. This chapter lays a foundation in Montessori pedagogy and dual coding theory with a review of research on ESL learners' reading development. This knowledge provides a basis for supporting the capacity of technologies that allow the integration of images, texts, and audio to improve reading understanding in upper elementary ESL children.

Literature Search Strategy

The literature search was conducted through databases that included ERIC, Education Research Complete, Education from SAGE, and Education Research Starters, the library research database of Walden University and of the University of Puerto Rico. The list of search terms used to conduct the literature search included *dual coding theory*, *ESL reading development*, *multimedia learning*, and *vocabulary instruction*. The articles reviewed in this study were mostly obtained from peer-reviewed professional journals, in electronic or print versions. Several books were also reviewed to examine the development of ideas and research regarding reading development in L1 learners and in ESL learners.

Theoretical Foundation

Montessori Philosophy and Pedagogy

Montessori education is child centered. Children learn and develop through their interaction with specially designed materials. Maria Montessori carefully and systematically studied the development of children from the philosophical standpoint that

within each child there is a wealth of possibilities for a better society. Through her research, Montessori developed a deep respect for children and a great admiration for their achievements, regardless of the environment in which they develop. This respect and admiration made Montessori understand that within children there are natural, inherent forces that move them to study and work hard in order to attain physical and mental development.

Montessori classified childhood development into four developmental periods. The first period is *infancy* (0-6 years of age). During this period, children absorb from their surrounding environments what they need in order to adapt. This period is characterized by the development of the senses and language. The second period, *childhood* (6-12 years of age) is when children expand interiorly through their search for connection with the culture and their peers. *Adolescence* (12-18 years of age) is the third period, during which young adults have a need to give back by serving their community. The last period defined by Montessori is *maturity* (18-24 years of age), when specialization starts (Grazzini, 1996).

In each of these stages, the existence of natural internal development goals can be observed. In order to reach these goals, there are established guidelines with directions that can be followed. Additionally, there are windows of development opportunity within the child's cognitive system that facilitate reaching developmental goals successfully. The process of transition from one stage to another depends on correctly meeting the child's needs in the previous period (Lillard, 1996). In fact, Lillard (1996) referred to a letter from Maria Montessori titled "The Four Planes of Education" in which she claimed

that schools were incapable of situating education at the service of the child's developmental needs.

In Montessori elementary education, children acquire knowledge and experiences through their senses (Montessori, 1966, 1967). Therefore, during the first period of development, children are presented with a variety of materials carefully prepared to promote the development of their senses. This instruction is critical to help the child, among other things, develop a strong sense of self-esteem as he or she learns to be independent in his or her immediate environments (home and school). In addition, the characteristics of the material employed, such as color, smell, taste, texture, weight, and height, help children establish order in their minds (Montessori, 1914). The central axes of the Montessori education during the following three stages of development are experiential learning and constant work in small investigations to deepen knowledge. Children are guided during different interventions from concrete experiences to the abstraction of concept and ideas. Although during Montessori's lifetime neuroscience was not as evolved as it is today, she knew that meaningful and concrete experiences gave children the opportunity to learn using more than one of their senses (multiple areas of their brains), thereby creating strong learning opportunities.

Liberty is the cornerstone of this methodology. Teachers must learn to respect the child's liberty to conduct his or her internal development. Montessori believed strongly that inherent to children were necessary faculties for their physical and mental development. To her, "our sole problem is that of offering the child the necessary nourishment" (Montessori, 1917, p. 70). That is why she believed that "the secret of the

free development of the child consists in organizing for him the means necessary for his internal nourishment, means corresponding to a primitive impulse of the child" (Montessori, 1917, p. 70). Consequently, the environment and the teacher who maintains and supplements it should contain the means for auto-education. A Montessori teacher should prepare materials and activities that awaken the child's curiosity while moving his or her internal interest to the necessary experiences in the path to adulthood. Therefore, in Montessori instruction, the first intervention is to introduce the child to Montessori's materials. A demonstration of how to use these materials is the initial step. The work of the child is to explore through interaction and experience in order to build new knowledge, improve new or existing skills, or develop cognitive capacities waiting to expand. His or her experience with the educational material is what helps the child develop his or her intelligence. For Montessori, "to help the development of the intelligence is to help to put the images of the consciousness in order" (Montessori, 1917, p. 202). A mind without order is one that has been passively filled with information. Montessori compared these minds to "storehouses in which new objects are continually deposited" (Montessori, 1917, p. 208).

The concept of order is what supports liberty. Order in the mind is reached because knowledge has been acquired through experiences that demonstrate and validate its functionality and the child's situation in relation to previous or new knowledge. In Montessori schools, children learn to choose, to prioritize, and to organize work. These skills are critical in current societies, where information is available from an infinite number of sources and can be accessed in just a fraction of a second. Technology

integration in Montessori classrooms has the advantage of the support of a learning system based on the child's intrinsic motivation. This allows children to recognize technologies in their learning environment as tools that facilitate learning and not as external rewards. The Montessori student is used to prioritizing. Therefore, the child understands that these resources are not for playing, but are rather part of their daily, valuable work materials. Moreover, Montessori students are habituated to actively participate in their learning process. For instance, in the classroom area assigned to language, children who are learning to read work with mobile alphabets, which they use to compose, read, and write words. Small environments, such as miniature farms, are among the materials used by small children to read labels and classify nouns. The decimal system and its operations are learned using materials that represent the units 10, 100, and 1,000. From this concrete approach, children move to more abstract materials for the same and more complicated operations, using multiple senses in the learning process. It is very common in a Montessori classroom to observe a child pairing up images with labels and small descriptions. Likewise, this learning practice can be observed through the entire curriculum, which strengthens the reading and writing processes through areas such as biology, history, and geography. Paivio's (1971) dual coding theory supports and validates Montessori instructional practices of using different senses during learning and is discussed in the next section.

Dual Coding theory

Information processing theory describes human learning as an interaction between long- and short-term memories. Learning depends on how effective the interactions

between these two memories are in terms of transferring relevant information to the long-term memory and accessing this information when needed (Lohr & Gall, 2008). Paivio's (1991) dual coding theory expands general information processing theory by considering that information can be stored in different forms. Paivio proposed that information was stored in verbal or nonverbal ways. *Nonverbal memory* is described as an imaging system because it is an area where sensed information is analyzed and where mental images are generated (Paivio, 1991, p. 54). This memory does not depend only on sight; it can receive visual and auditory information as well. *Verbal memory* manages the storage and processing of language information and the generation of speech (Paivio, 1980). Furthermore, these memories are structurally located in different areas of the brain and can function independently (Paivio, 1991). This independence implies that perceptual and language activities can be observed alone (Paivio, 1980). Nevertheless, each of these memories can activate the other, as well as transfer and convert information from one to the other.

In addition, Paivio (1980) defined three levels of processing information: the representational, referential, and associative levels. The *representational level* involves the activation of the long-term memory by a corresponding stimulus. For example, a word may activate a verbal representation. The *referential level* involves the activation of representations in one system by another through their interconnection (Paivio, 1980), as happens when generating a mental image to name something or when naming an image. The *associative level* refers to connections among linguistic and image units, such as the use of an image stored in the long-term memory to identify or learn a new word that does

not necessarily represent the same thing. The associative level is important in the process of learning abstract words such as *fearlessness*. When using images or sound, a person can create a representation of the word or connect its meaning to previous units of information stored in long-term memory.

Farley et al. (2012) highlighted the contribution of imagery to the process of vocabulary learning. Vocabulary meaning retention is essential for understanding any second language. In particular, Farley et al. took the case of remembering concrete versus abstract words. In an attempt to demonstrate the effectiveness of using images, they employed symbolic, metaphorical, or emotive imagery to support meaning retention of abstract vocabulary items. Their sample consisted of 160 students enrolled in a first-semester Spanish course. These students did not have a background in Spanish, nor had they taken any Spanish courses before the intervention. Passive interaction with content was required from the learner only to maintain attention on the screens. In Farley et al. (2012), students with image interventions outperformed those without the images in learning abstract words. However, results were mostly not statistically significant. Nevertheless, these results suggest the value of introducing assisting visual elements in learning abstract and concrete vocabulary. It is important to mention that, in both cases, students' long-term knowledge showed a significant decrease, possibly as a result of the learner's passive role in the learning process. The results of this study need repetition, and similar research should be performed with different age ranges.

The amount of information that can be retained in working memory is limited. Therefore, the possibility of overload needs to be considered (Mayer & Moreno, 1998).

When overload occurs, the learner's capacity for processing information is not sufficient for the total processing demand (Mayer & Moreno, 2003). Conversely, meaningful learning occurs when a learner is capable of archiving relevant information, accessing it when needed, and using it comprehensibly to establish new learning connections. However, additional conditions need to be taken into consideration. For instance, the connections between storages can be made only if both pictorial and verbal information is present in the working memory at the same time (Mayer & Moreno, 1998). Evoking an image to connect to a language code or vice versa can enable this process. Similarly, using an auditory or visual stimulus when learning a language might create effective learning conditions.

Montessori (1965) was aware that presenting information both visually and verbally contributed positively to the child's learning process. Indeed, in Montessori pedagogy, grammar is taught through concrete symbols with specific qualities that are presented to children in order to help them understand the function of words in sentences. Further, throughout the entire curriculum, information is normally presented with images and text simultaneously. Current educational technologies allow the development of these pedagogical practices by facilitating instant integration of audio, video, and images into the learning process. They have the potential to make the learning process more meaningful when students are allowed to create their own relevant learning tools while using them. Consider cellular phones and how simple taking a picture or a video and sharing it with friends or families has become.

Literacy Versus Reading

Reading is the interpretation of something that is printed. Literacy is a person's capacity for reading and writing. Snow (1998) defined literacy as broader and more specific than reading. Reading is only a part of a person's literacy capacity. Educational background, culture, environment, and social context influence a person's literacy potential. Therefore, when referring to literacy, there is a broad scope of additional knowledge that needs to be taken into consideration. Snow referred to this additional knowledge as fundamental in order to understand, for example, a dissertation on quantum physics. Therefore, reading capacity is not enough for literacy; there is additional knowledge that will be influenced by many internal and external variables required to understand what is being read. Nevertheless, reading development is one of the most important elements of literacy and it represents one of the greatest challenges for human development. Even though children have a sensitive period for language acquisition, learning to read and dominating the skills needed to read fluently and to understand what is being read takes many years of practice and hard work. This is true for L1 learners and ESL learners.

English as a Second Language (ESL) Learners and Reading Development

The U.S. Department of Education considered ESL learners as those who represent nation-origin-minority-groups who are limited-English-proficient (Francis et al., 2008). These groups come from different cultural backgrounds and their first languages differ significantly. This differentiation in previous knowledge, culture, and first language influences the processes of learning a second language (Gutierrez, 2010;

Lesaux et al., 2008). This literature review is mostly related to individuals whose primary language is Spanish, due to the targeted population for this study.

Gutierrez (2010) described the *Common Underlying Proficiency* (CUP) model, which supports the existence of a rapid transfer of acquired skills from one language to another. Manis, Lindsey, and Bailey (2004) investigated cross language transfer from Spanish to English. They wanted to test if significant cross language relationships should be found between print knowledge, phonological awareness, and rapid automatic naming (Manis et al., 2004). Manis et al. initial sample consisted of 303 Latino kindergarten children from a Texas border town participating of a district wide early-transition bilingual curriculum called "Esperanza". This program begins in kindergarten with phonological awareness activities, letter introduction, and oral language training in both Spanish and English. The program continues until second grade. A battery of tests was administered in kindergarten, first, and second grade to measure variables such as letter knowledge, word identification, sentence recall, confrontation naming, phonological awareness, and print concepts (Manis et al., 2004). Manis et al. stated that there is transference of skills from Spanish speakers to their English learning processes. Significant and moderately sized correlations were found between Spanish measures in kindergarten and parallel English measures in first graders. Manis et al. demonstrated that a variety of theoretically important skills can be measured in Spanish and can be used to predict future reading achievements in English. Additional empirical evidence suggests that the processes and strategies for acquiring reading skills in a second language are similar to those for acquiring reading skills in a first language (Carlo et al., 2008; Francis

et al., 2006; Gottardo & Mueller, 2009; Gutierrez, 2010). These advantages can be attributed to some similarities between both languages, English and Spanish. For example, both languages are alphabetical. In alphabetical languages words are composed of characters from a finite set or alphabet. Nonalphabetic languages, for example, Chinese, symbols represent syllables instead of phonemes. In addition, in English and Spanish reading is done from left to right. Another simple similarity is on many words (such as conclusion and 'conclusión'), which are written very similarly and share the same definition.

The main differences observed between L1 learners and ESL learners are primarily associated to vocabulary knowledge and, consequently, reading comprehension (Biemiller, 2005; Carlo et al., 2006; Gottardo & Mueller, 2009; Lesaux et al., 2010). Biemiller (2005) claimed that in fifth grade ESL learners have an average vocabulary size of a third grade L1 speaker. Some of the explanations for this gap include poor oral language exposure from ESL learners at their close environments, such as their home or playing areas. Additionally, the primary focus in lower elementary grades is decoding skills, more than vocabulary learning. Nonetheless, for both native speakers and ESL learners the process of developing numerous proficiencies associated with reading is a complex task that involves an assorted number of cognitive resources.

The act of reading involves a combination of interconnected abilities and the development and maintenance of a motivation. The effective combination of these abilities determines a person's capacity to understand what is being read. Some of these abilities include the knowledge to understand how phonemes (units of sound that can

change meaning) are connected to print, the ability to decode unfamiliar words, the ability to read fluently, sufficient background information, sufficient vocabulary to foster reading comprehension, and strategies to construct meaning from print (The No Child Left Behind Act). These five elements of reading are embedded on the Snow (1998) proposition about what constitutes an effective reading program. Snow believed the most important predictors of success and failure in reading are "intellectual and sensory capacities, positive expectations about and experiences with literacy from an early age, support for reading related activities and attitudes, and instructional environments conducive to learning" (Snow, 1998, p. 101). Further predictors are knowledge of letter-sound relationship, vocabulary, reading comprehension strategies, and motivation (Becker, 1977; Chall et al., 1990; Chall & Conard, 1991; Francis et al., 2008; Lesaux & Kieffer, 2010; National Institute for Literacy, 2001; Scarborough, 2001; Silverman & Crandall, 2010; Snowling & Hulme, 2011; Spira et al., 2005; Storch & Whitehouse, 2002).

There are two theoretical frameworks that intend to explain the reading process. One is the *Simple View Reading Model*, which states that word reading ability (decoding) and listening comprehension account for nearly all the variance in the understanding of what is being read (Gough & Tunmer, 1986). However, Joshi and Aaron (2000) argued that the *Simple View Model* does not take into consideration important variables such as those related to the child's familiar environment and his interactions with the elements of these environments. Therefore, Joshi and Aaron (2000) expanded the *Simple View Model* to what they called the *Componential Model of Reading*. In this model decoding is an

element of sight-word reading which is the combination of decoding skills and fluency. Reading will be the result of decoding, speed (fluency), and reading comprehension skills (Joshi & Aaron, 2012). In both models word reading skills are the foundation in which the child can construct meaning. Likewise, decoding skills such as phonemic awareness and phonics (relating spelling to speech sound) are more influential in the reading process during the first years of the child language development (Francis et al., 2006). Decoding skills or letter sound relationships (phonemic awareness, phonological awareness, phonics, phonological decoding) encloses a group of language proficiencies critical to the initial stages of the reading process. In early childhood, decoding is the real challenge and will be the greatest determinant of a child's ability to pronounce and read a word regardless of his/her understanding of its meaning (Francis et al., 2006; Snow, 1998). According to Snowling and Hulme (2011) two of the three main characteristics of a skilled reader are the ability to decode accurately, and to read fluently. Geva and Farnia (2012) evaluated the development of reading fluency and language proficiency in a sample of 390 ESL, and 149 L1 speakers. Their results demonstrated that from second grade to fifth grade word reading accuracy and fluency evolved from being one measure to being two independent factors. In fifth grade, fluency has a more significant role on reading comprehension than accuracy. It is noteworthy that in fifth grade syntactic skills and listening comprehension were identified as additional language proficiency components for reading comprehension in ESL learners although not for L1 speakers. These results suggests that predicting factors for reading comprehension in ESL learners are not identical to L1 speakers and there might be additional variables that should be

considered in order to understand upper elementary reading comprehension for ESL learners. In addition, apparently a change occurs in the child's educational needs where decoding is no longer a limitation allowing new necessities to be noticed. Research suggest these needs cannot be observed before because teacher's and child's attention is directed toward overcoming reading decoding challenges, overlooking the need for vocabulary acquisition (Geva & Farnia, 2012; Mancilla-Martinez & Lesaux, 2010, Lesaux & August, 2006; Snowling & Hulme, 2011; Lesaux & Kieffer, 2010; Silverman & Crandall, 2010; Spira et al., 2005). This is specially observed in ESL children, whose language spoken at home usually limits their acquisition of English vocabulary. Most of the studies related to reading development for ESL learners are focused on decoding processes in lower elementary grades (from kindergarten to third grade). It may appear that children need to overcome decoding conflicts in order to improve their language development in upper elementary. That is why, decoding skills are predictors of upper elementary reading and comprehension capacities. Decoding skills development has been widely studied for the creation of reading programs that contribute to children's future reading progress through the educational system. For example, Nakamoto, Lindsey and Manis (2012) evaluated the development reading and oral language skills in 502 ESL learners from kindergarten to third grade whose first language was Spanish. The children followed one of three different intervention programs: a transitional bilingual, a dual-language, and an English immersion program. In the transitional bilingual program instruction was given in both Spanish and English. Each year children's Spanish instructional time was gradually reduced. Children in this program were taught to read

and write initially in Spanish. In the dual-language program children were taught some topics in Spanish and some in English in equal proportions. Science and social studies were taught in Spanish and math was taught in English. Children in the English immersion program were placed in classrooms with predominantly English proficient peers and were offered all-English instruction. In Nakamoto et al. the student's level of participation in the program was significantly associated with their mean level of performance in their reading and oral language measures. Students in the transitional bilingual and dual-language programs scored significantly higher than those in the English immersion program on the Spanish oral language decoding and reading comprehension measures. Similarly, program participants with more exposure to English had better results in English language skills. Also, Nakamoto et al. found that all the regression paths for each grade measured did not vary across the programs. Therefore, the predictors of reading comprehension in both languages did not vary either. Moreover, the same measures can be applied to identify which children in the sample would have reading compression difficulties in the future regardless of their language of instruction. In addition, their results revealed that the decoding skills in first grade predicted reading comprehension in third grade. Apparently, in subsequent grades these decoding skills become less important due to, for instance, changes in the complexity of topics and readings. Furthermore, once these decoding skills are beginning to be acquired they become necessary tools to meet the demands of the academic grade.

Unlike the characteristics observed in lower elementary grades, such as the importance of decoding skills, in upper and middle school vocabulary knowledge and

comprehension skills appear to be fundamental factors of reading. Kieffer (2012) used data from a national-representative longitudinal database on a cohort of ESL learners whose first language is Spanish in the US, to investigate to what degree English and Spanish language competence serves as a predictor of reading skills in elementary and middle school years. Kieffer (2012) observed that vocabulary measures were statistically the finest predictors in upper and middle grade levels of English reading. English learning in upper elementary grades demands effective vocabulary acquisition practices.

Although most studies strongly related vocabulary knowledge to reading comprehension, it is important to consider special conditions where evidence proved otherwise (Flanigan, Templeton, & Hayes, 2012; Harrison, 2011; Logan, 2011; Montgomery & Hayes, 2005; Nagy, Berninger, & Abbott, 2006; Steele & Watkins, 2010; Wanzek, Wexler, Vaughn, & Ciullo, 2010). Mancilla-Martinez and Lesaux (2010) conducted a longitudinal study with a population of ESL learners whose first language is Spanish from low-income households, classified as low achieving struggling readers. Students were followed for a period of six years, until their fifth grade. Mancilla-Martinez and Lesaux (2010) use longitudinal structural equation models of latent growth curves to develop a model of English reading comprehension. This analytic approach allowed them to link the children's initial status for vocabulary and word reading at age 4.5 to English reading comprehension achievement at age 11. Mancilla-Martinez and Lesaux (2010) found that Spanish vocabulary and word reading path were not significant predictors of English reading comprehension. All throughout their model word reading was more strongly associated with reading comprehension measures than with

vocabulary. Although both factors were influential, the study results demonstrated that word reading exerted a greater influence on comprehension outcomes than vocabulary at age (Mancilla-Martinez & Lesaux, 2010). However, for Mancilla-Martinez and Lesaux the level of reading development of these children was extremely low even in fifth grade, for this reason, in this study word reading influenced reading comprehension more significantly than vocabulary knowledge. Also, their decoding skills were deficient; consequently, vocabulary skills were not as influential as expected.

Nevertheless, there is empirical evidence that vocabulary knowledge and strategies to learn vocabulary influence the continual improvement of fluency in addition to being critical for reading comprehension in L1 speakers and ESL learners (Lesaux et al., 2010; Riedel, 2007; Schilling, Carlisle, Scott, & Zeng, 2007; Yovanoff, Duesbery, & Alonzo, 2005). For example, Yovanoff et al. (2005) wanted to establish up to what degree fluency and high-level vocabulary knowledge impact reading comprehension ability as students progress each successive grade. In Yovanoff et al. linear regression models were developed to predict if reading comprehension fluency has an impact on vocabulary and vice versa. Yovanoff et al. expected that reading fluency would decrease as a predictor of reading comprehension primarily because students show increasing mastery of these skills, resulting in less predictive value. Meanwhile, vocabulary will be more important because knowledge acquisition requires increasingly greater vocabulary as a function of grade level. Yovanoff et al. results proved that reading comprehension is related to developmental factors and is a multidimensional process. In terms of the developmental factor, in elementary grades fluency is most important because it connects

the alphabetic principles and consolidates phonemes and graphemes. As students become more skilled on fluency, texts are increasingly difficult, in part because they demand understanding of the meaning of more complex words. Schilling et al. (2007) wanted to investigate the validity of fluency measures as predictors of early elementary students' reading achievement. Similar to Yovanoff et al. study, Schilling et al. found diminutions in the magnitude of correlations between the fluency measures and reading comprehension from second to third grade. Thus concluding that fluency might be less closely associated with comprehension as students gain experience (and fluency) reading connected text, perhaps because of the increasing importance of other factors such as vocabulary knowledge (Schilling et al., 2007). In Schilling et al. *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS) were validated as predictors of fluency measures. Schilling et al. gathered data from 44 schools from nine districts, testing children from first through third grade during the fall, winter, and spring. Their results demonstrated the DIBELS at-risk benchmarks for oral reading fluency were mostly accurate identifying second and third graders who were reading below the 25th percentile at the end of the year. However, the test could not predict reading levels for many of the second and third graders. Schilling et al. suggested supplementing DIBELS measures with measurements of reading comprehension and vocabulary. Thus, vocabulary measures are suggested for reading assessment in second and third grades, that is, in more advanced ages, where decoding elements are not the only factor influencing the reading process. Profiling ESL children might help to develop effective assessment tools and interventions for upper elementary children.

In order to define a possible profile for ESL children in upper elementary, Lesaux and Kieffer (2010) compared, under the same pedagogical context, ESL learners with L1 struggling readers. The study sample was composed of 263 children with an average age of 12 years old and under the 35th percentile in the assessment reading comprehension test. Using multiple evaluation tools Lesaux and Kieffer assessed word-level reading skills and oral language measures. They observed that both groups showed comparable and similar sources of difficulties. Lesaux and Kieffer (2010) profiles suggested that L1 children with reading difficulties and ESL learners by middle schools have fairly good decoding skills, but a significant deficiency in vocabulary skills. This suggests that by middle school both groups would benefit from the same instructional approaches. Therefore, vocabulary instruction programs should be developed with the goal of its latter implementation in mainstream classrooms of both L1 speakers and ESL learners.

Following this lead, Lesaux et al. (2010) found that native speakers and ESL learners perform at similar levels to L1 speakers on measures of phonological processing, word reading and spelling. They followed 87 students from fourth to sixth grades. When compared they observed that in fourth grade and sixth grades vocabulary and listening comprehension skills were the main predictors of reading comprehension. Essentially, vocabulary acquisition and reading comprehension are skills that need to be developed in more advanced stages of learning language for ESL learners and L1 speakers (Lesaux & Kieffer, 2010; Swanson, Rosston, Gerber, & Solari, 2008). Swanson et al. (2008) used a battery of measures in low-income Latino third grade children from two different schools to investigate the role of vocabulary and grammatical skills in children who are learning

English as a second language. They consider phonological measures, reading measures, oral language measures and syntax measures. Their results showed that oral language, syntax and vocabulary, when compare to phonological awareness measures, contributed substantially to reading skills in their third grade sample. They also demonstrated that at third grade, even children learning English as a second language have acquired decoding and word identification skills.

Vocabulary Instruction

Vocabulary acquisition is an academic challenge for L1 speakers, and more so to ESL learners. During a child first years of development vocabulary gains are attributed mostly to oral language communication. Oral language communication skills are those related to the child's vocabulary for communication and to his/her listening comprehension capacity (Lesaux et al., 2010). Therefore, while in early education children learn decoding, vocabulary is primarily learned at home or by their interaction with the school environments and their peers (Biemiller, 2005). In most of ESL learners' home environments oral communication skills are developed only for their first language. Even though there is empirical evidence of a transmission process from Spanish first language to English second language, this is not enough and these circumstances present a challenge to teachers and learners. As the child progresses academically vocabulary demands increases to understand the texts studied through the entire curriculum in addition to the essentials of oral communication skills, reading fluency development, and grammar understanding. Snow and Kim (2007) estimate that high-school English only graduates need to learn 75,000 English words between the ages of 2 and 17. According to

Biemiller (2003) learning vocabulary is so critical that an average child should learn between 800 and 900 root words a year. The problem seems to be that from kindergarten to third grade children are learning mostly to decode, which is the basis for reading development. While decoding skills could be learned in a period of two-years, vocabulary instruction is a never-ending effort (Biemiller, 2003). The challenges of determining vocabulary goals per grade increases with ESL population due to the evident lack of exposure to oral language communication. Nation (2006) proposed the estimation of the quantity of words needed in order to comprehend certain texts such as newspapers and novels. Based on previous studies (Hu & Nation, 2000), Nation presented that 98% of text coverage words would be needed for most learners to gain adequate comprehension (Hu & Nation, 2000). Nation wanted to determine the amount of vocabulary needed to reach a comprehension of a variety of written text and spoken communication. He found that the ideal vocabulary knowledge to manage most written text is between 8,000 to 9,000 word-families. However, the largest variation in vocabulary occurs mainly in the first 1,000 word-families and proper names. According to Nation (2006) these word-families allow a high percentage of understanding of a reading. Consequently, the greater educational effort should be on those first 1,000 word-families. Furthermore, distinctions needed to be taken into consideration within these word-families. Miller and Roodenrys (2012) studied word frequency. They divided vocabulary into low frequency (LF) and high frequency (HF) words. Word frequency is the amount of times a word can be encountered in written or spoken language (Miller & Roodenrys, 2012). Miller and Roodenrys (2012) observed that HF words are learned more rapidly than LF. However,

the best results were observed when both word lists were mixed. Therefore, it is not just the word frequency which facilitates its learning, the context or in Miller and Roodenrys study, the list in which it is presented that determines how effectively it is recalled. Therefore, Miller and Roodenrys suggested presenting words in a combination where HF words appear initially followed with LF words. They propose HF words might serve as a resource for the recall of the following LF words.

Learning vocabulary effectively depends on the contextual knowledge about the word being learned (Stahl, 2003). However, contextual knowledge about the word is not enough since its relationship to other words and its transformations into morphological forms would allow the reader to understand and learn additional related words and to interact more effectively with the text (Lesaux et al., 2010). Several strategies to support vocabulary knowledge development have been proposed throughout the literature. One of these is introducing word through explanations in an informal language instead of using the dictionary (Beck & McKeown, 2007; Carlo et al., 2008; Mancilla-Martinez & Lesaux, 2010). When using commonly encountered vocabulary to introduce a definition the child can connect the word more easily to previous knowledge. Once a definition is presented, different contexts where the word can be used are explored. This increases the opportunities of the reader to comprehend the word meaning depending on the circumstance where it is used (Beck & McKeown, 2007; Carlo et al., 2008; Mancilla-Martinez & Lesaux, 2010; Stahl, 2003; Stahl & Nagy, 2006). Knowledge of the word in different contexts opens an opportunity for the child to participate of activities that provide immediate contact with the words (Beck & McKeown, 2007; Biemiller, 2003;

Carlo et al., 2008; Mancilla-Martinez & Lesaux, 2010) and that can take the child to deeper and mindful interactions with the vocabulary (Beck & McKeown, 2007; Carlo et al., 2008; Lesaux et al., 2010; Mancilla-Martinez & Lesaux, 2010). Lastly, intrinsic motivation has an important role in vocabulary learning (Kirby, 2007; National Reading Panel, 2000; Shany & Biemiller, 2010; Snow, 1998). Readings should be relevant to the students and should draw their attention and interest. The importance or relevance of readings in the reality of the reader, allows them to identify and interact with what they read. For example, situations or problems in readings presented to students should be similar to their reality so that they achieve empathy and increase meaningful interaction with the text (Ebe, 2012). Lack of motivation affects the student's ability to concentrate on and to effectively delve into a reading. This causes reading to become an unintelligible torture. Ebe (2012) presents evidence that when students have previous experiences with the topics of a text, comprehension can be achieved more fully. Culturally relevant texts allow a connection between the reader's background knowledge and the reading (Ebe, 2012). In Ebe's study four students participated of the intervention. Each student reads one culturally relevant book and one not relevant. In this study the four participants achieved better reading comprehension of the cultural relevant text (Ebe, 2012). It is possible that these connections have an engaging factor and at the same time includes a greater amount of vocabulary known to the reader. However, further research on this matter should be conducted with a greater sample size.

In addition to word frequency, another distinction in vocabulary learning is breadth versus depth. *Breadth vocabulary* refers to the number of words known and *depth*

vocabulary is the multiple representations of known words (Proctor et al., 2009). A common practice in teaching vocabulary is presenting a list of words to the students from the reading they are going to make. Students must look for the words on a dictionary; write their definitions and sentences with them in index cards. Proctor et al. (2009) argued this practice would be more beneficial if the definition agrees with the word context. Consequently, Proctor et al. claimed that effective vocabulary programs to improve reading comprehension are contextually rich, attentive to establishing deep meaning connections, and extended in time to provide multiple encounters with each word. Therefore, to maximize results in reading comprehension due to vocabulary learning it is not enough to learn many words, instead, it is more significant to increase richness of vocabulary knowledge (Proctor et al., 2009). To corroborate these theories Proctor et al. explored the use of a multimedia environment to promote learning of depth and breadth vocabulary. Particularly, they wanted to study *semantic depth*, which is another component of vocabulary knowledge that refers to the ability to express and connect word meaning across a variety of contexts as well as to identify how words are connected to one another in this network (Proctor et al., 2009). Proctor et al. believed semantic depth contributes importantly to reading comprehension in upper elementary. A total of 35 fifth graders were selected for this study. The sample was divided into 24 bilingual and 11 monolingual students. Students were exposed to a media environment that promoted deep study of vocabulary. However, student interaction was limited to answering questions after viewing the different activities. According to Proctor et al., oral language skills and semantic depth accounted the most for reading comprehension on the

sample. Proctor et al. study showed no conclusive results due to a small sample size, in order to confirm his results replication of the study is required. Additionally, the sample was not homogeneous since native language varied, for some it was Mandarin while for the others it was Spanish. Although Proctor et al. (2009) used a multimedia environment, student's participation was primarily passive. In educational technology, the level of interaction with the resources influences the educational outcome significantly (Mouza, 2008). Therefore, although a multimedia environment can provide contextually rich spaces where learners can establish deep meaning connections, the student's active role continues to be of extreme importance and needs to be considered. In any active learning activity the student's participation allows the cognitive creation of multiple connections in order to have a deeper or strong learning process. For example, through a multimedia environment such as a video, with which students can associate sound, letters and images to learn new vocabulary, there can be connections made between the definition, the sounds, animations and the word. Moreover, if the student is the one who gathers the images, the sounds, and even creates a video, the learning process is amplified and the neurological connection could also be maximized. Therefore, educational technologies are able to enhance students' second language learning by creating multiple channels to connect knowledge and by allowing students to be the active creators of these channels and connections. Another example is the use of virtual worlds as learning tools for language learning or improvement. *Virtual worlds* or MUVES (multi user virtual environments) are computer-generated environments created with multiple technologies that allow their participants to interrelate with elements of a real world society

(Balcikanli, 2012). In this type of environment students can use the technology to facilitate learning experiences and to play an active role in the process.

In order to gain insights on this matter, Balcikanli (2012) explored the experiences of English as Foreign Language (EFL) learners and Turkish as Foreign Language (TFL) learners with the virtual world platform *Second Life*. Balcikanli was only interested in the students' experiences in the virtual world. Therefore, no experimental procedures were taken into consideration. The population of the study was a convenience sample and language-learning gain was not measured in any standardized form. Balcikanli used semi-structured interviews to gather the qualitative data. This study consisted of two groups of seven American learners studying Turkish in the U.S. and eight Turkish EFL learners who studied English in Turkey at college level. *Second Life* is a virtual 3D community where participants can interact with each other and with the virtual environments. The students had the opportunity to share information and play within the Second Life platform while having to manage the interactions in the new language they were trying to learn. Each student, in both groups, had to spend thirty minutes on practicing Turkish and then thirty minutes on practicing English. Both groups had to spend two hours a week in Second Life. Aside from the challenges reported by the students and related to the learning process of using Second Life, the students were positive toward the use of this type of learning environment to improve their language skills. Balcikanli concluded that the majority of the students felt quite relieved in Second Life. In both groups, at the beginning the students felt anxious for the opportunity, then they entered into a confusion state, not being clear of what to talk about, and finally they

went into an excitement stage. The virtual world experience was the closest thing to a context of immersion in the languages they were studying, which can prove to be very difficult when learning a language far away from a culture that speaks it.

Finally, it is important to consider the differences between concrete and abstract words. Sadoski (2005) claimed concrete words were less difficult than abstract words because they can be represented easily in two codes (visual and nonvisual). The word 'boat' can be represented by an image and by narration of its function. However, it is more difficult to represent with pictures the word 'hope'. Furthermore, in some cases word meaning can be connected directly to multiple verbal and nonverbal symbols (Sadoski, 2005). For example, the word 'ring' can be connected to wedding, boxing, burglary or telephony. Consequently, when selecting words to be learned it is important to consider how they might be connected to concrete or abstract ideas in order to improve learning outcomes. Even so, the use of technologies such as videos to represent abstract concepts might be a pedagogical option to facilitate the representation of meaning or to construct meaning or introduce other proven effective language learning strategies such as concept mapping. In fact, learning countless science concepts can be a challenge mainly because of their level of abstraction. Hwang, Wu and Kuo (2013) studied the effects of different touch technology-based concept-mapping strategies on the learning attitudes and learning achievements of 92 sixth grade students (12-13 years old) in a natural science course. The treatment groups used concept map creation with some technology and the control group had a paper-and-pencil concept-mapping approach. Hwang et al. (2013) used a scale for measuring the students' attitudes toward the natural

science course, and a questionnaire of the student's acceptance of the concept-mapping approach. They found that the students in the treatment groups adopted better learning attitudes toward the use of concept maps for science learning than those of the control group after their interaction with the technology. Their results showed that the students in the treatment group had a significantly more positive perception of the usefulness of concept maps for learning than the control group (Hwang et al., 2013). Therefore, the use of technology to address a strategy to learn science concepts was significantly beneficial to the learning process and to keep students engaged in the process. In another similar study, Mellecker, Witherspoon, and Watterson (2013) demonstrated that the experience of students and teachers using active gaming technology to acquire nutritional knowledge was positive and enriching. A total of 57 students in grades 3, 4, and 5 participated of this study. Although this study did not have a control group to compare with the pre and posttest score of the students showed learning improvements in each grade level and on the overall average. Mellecker et al. study is preliminary and needs further experimental exploration, but the online nutrition games proved to be a positive pedagogical practice. In addition to the pre and posttests, children made journals about their experience during these learning activities. This qualitative data showed students were aware of their learning process and they used the new acquired knowledge to make nutritional decisions (Mellecker et al., 2013).

Considering research recommendations regarding vocabulary learning, Lesaux et al. (2010) developed a complete program for teaching vocabulary. They wanted to determine the impact of their vocabulary program in reading comprehension in ESL

Spanish learners enrolled in an urban middle school. Lesaux et al. program targeted depth vocabulary knowledge and words with high academic utility while using direct instruction and word learning strategies. Additionally, the program considered the use of different activities that allowed multiple word exposure. The sample consisted of 476 sixth graders from which 346 were ESL and 130 were English native students. The majority of the sample had Spanish as their first language. The intervention consisted of teaching words in a series of activities during eight days. Starting with reading an article that included the vocabulary, developing strategies for using and understanding the vocabulary and, finally, using words to write under new contexts. The results showed a small improvement of reading comprehension, which Lesaux et al. believed was due to the assessment tool used in the study. Apparently, the test for reading comprehension did not include the academic words learned during the program. Consequently, even though the test showed an improvement it was not statistically significant for the sample. In addition, ESL students remained behind L1 speakers in vocabulary and reading comprehension, which implies that they might need a more intensive approach in more individualized settings (Lesaux et al., 2010). Lesaux et al. vocabulary program considered the most effective practices in language programs discussed by Slavin, Cheung, Groff, and Lake (2008). Slavin et al. (2008) made a systematic review of research on achievement outcomes for reading programs in middle and high schools students. Slavin et al. (2008) found that the programs with the most effective results where those that had a critical cooperative learning component, focused on improving classroom teaching while changing the traditional practices in the classrooms. In

addition, Slavin et al. demonstrated that curricula and computer-assisted programs alone were as effective as these practices. Instead, mixed-methods models are expected to have greater influence in student's academic reading achievements. Consequently, it leaves open the possibility that active engaging cooperative student interaction combined with the use of multimedia environments increase vocabulary acquisition and reading comprehension.

The role of vocabulary on reading comprehension for L1 and ESL learners has been intensively studied, as shown above. However, there is seemingly a need for additional research on effective instructional practices that support vocabulary development in order to contribute to better text comprehension in upper elementary and middle school grades. Multimedia technologies are promising tools as instructional components in that they allow students to connect vocabulary; they increase their exposure to multiple experiences with it; and they add an active interaction component while linking the verbal code to the visual code. Multimedia studies have been conducted mainly on college students who passively attend to the presentation of information. Hence, there is a need for studying effective uses of multimedia technologies as instructional tools for active vocabulary learning in upper elementary levels.

Multimedia Learning

Multimedia learning is the presentation or use of information with images (pictures) and words to increase the effectiveness of the learning process (Mayer & Moreno, 2003). Most of current informational and communicational technologies are an opportunity for instructional multimedia development. These technologies offer multiple

options to achieve multimedia instruction. However, it is critical to consider the induction of cognitive overload in learners when information is presented with multiple multimedia resources such as videos, text, audio, or animations. When a cognitive overload occurs, the learner's intended cognitive processing exceeds the learner's available cognitive capacity (Mayer & Moreno, 1998; Mayer & Moreno, 2003). A person's total processing demand in multimedia learning is directly proportional to his or her essential processing, incidental processing and representational holding (Mayer & Moreno, 2003). *Essential processing* is defined, as the capacity required for making sense of what is being observed. Therefore, it includes the selection, classification, organization, and integration of information (Mayer & Moreno, 2003, p. 45). *Incidental processing* refers to one that takes place without the active attention of the learner; it takes place, for instance, when a presentation has a background audio that is not essential to understand what is being presented. Even though this processing does not require the same amount of processing capacity that essential processing does, it still generates cognitive activities, which influence the person's cognitive capacity. *Representational holding* is the use of a visual or auditory element to preserve a mental representation in the working memory during a period of time (Mayer & Moreno, 2003). For example, a learner is presented with a slide of an illustration, and in the next slide, with text related to that image. In this case the learner has to retain the image in his short-term memory in order to make use of it when the text is presented. If a multimedia learning resource has a total processing capacity greater than the learner's cognitive capacity then cognitive overload will probably occur.

Consequently, arrangement of visual and auditory instructional resources has an impact in the learning processes, specifically in the demand of a person's cognitive work. These theoretical considerations are evidenced by several studies, mostly on adults, where multimedia instruction had presented contradictory results (Farley et al., 2012; Rosen et al., 2012; Schwartz, 2005; Silverman & Hines, 2009). The results of these studies will be presented in the following paragraphs. However, these results are explained by cognitive overload variables. Understanding what is the most effective form to present information and combine media objects are inquiries constantly made in multimedia instruction. Mayer (2001) claims that students learn better from words and pictures than from words alone. According to him the image is an element that allows learners to create meaning and make sense of what they are learning. Mayer and Moreno (2003) developed a set of principles to guide the creation of tools and activities that integrate audio, text and visual technologies for learning. Among them, Mayer and Moreno (2003) suggested transferring words as narration rather than as on-screen text, using learner-controlled segments rather than continuous units, excluding extraneous material, placing printed words near corresponding parts of the graphics, reducing or eliminating redundancy, and presenting narration and visual input simultaneously. Therefore, research had concentrated on optimal combinations of learning objects to stimulate learning without overloading individual's cognitive capacities. The nature of these considerations is cognitive overload, which I believe would not be a variable to consider if students are the ones building the multimedia units during their process of constructing meaning.

Mayer and Moreno (1998) worked with 78 college students to study ways to avoid cognitive overload when presenting multimedia information. In their study, students were presented with animations of information about either the process of lightning formation or the operation of the braking system of a car. Students were divided into two groups. One group received an animation with concurrent narration of the information (Group AN) and the other group had the animation with concurrent on-screen text (Group AT). The difference between each group was in the way verbal information was presented. Mayer and Moreno (1998) claimed that in Group AT students would activate just the visual (an image and on-screen text) memory; thus, the cognitive load in this group was only visual. While students in Group AN would be able to activate both visual and auditory memories because cognitive load was divided among the visual (an image) and auditory systems (the narration). Mayer and Moreno (1998) measured student's capacity to retain the information received and their ability to transfer this information to other situations. They also measured through matching student's learning of vocabulary definitions. Students learning the process of lightning formation or those learning the operation of a car's braking system by image and narration of text (Group AN) outperformed their peers in image and on-screen groups significantly in the three different assessment tools. Therefore, on Mayer and Moreno (1998) study, students' learning achievement of sequential information was increased when the information was presented in a combination of visual and auditory sources.

In a similar study, Schwartz (2005) considered auditory overload in 72 students between the ages of 10 and 12 when presented with 22 slides of information. She

measured students' attention using phasic heart rate, tonic heart rate, and skin conductance level. To determine student's retrieval capacity of the information presented Schwartz (2005) used the technique of free recall (participants have to tell everything they remember without clues). Schwartz created 22 scenes using Flash technology to present information about animals living on a fictional planet. Each of the lessons used in the study had four segments and each segment represented four different delivery combinations of animation and sound: no animation/no sound effect, animation/no sound effect, no animation/sound effect, and animation/sound effect (Schwartz, 2005, p. 63). Schwartz found the greatest learning achievements in the segments with animation and/or sound compared to the segment with the no animation/no sound combination.

Rosen, Fullwood, Henley, and King (2012) modified Schwartz (2005) study by loading the visual mode instead of the auditory mode. Rosen et al. tested 55 undergraduate college students learning vocabulary under three different conditions. The first condition was to read a sentence in context; the second one, to observe a picture with a narrated sentence; the third one was to experience a picture (visual and nonverbal), with the embedded word (visual and verbal) while listening to a narrated (nonvisual and verbal) in context sentence. In Rosen et al. the third group was the only one able to transfer the studied words to new situations. In this group, the vocabulary presentation using the combination of image, text, and narration facilitated deeper vocabulary learning. Rosen et al. suggested the repetition of this study in different lower educational levels such as elementary and middle school. According to these studies, in a passive learning mode, integration of multimedia helpers facilitates learning. Despite this fact,

none of them explores a more active role of students with the multimedia elements and long-term learning results.

Similar attempts to study multimedia support of instructional strategies for vocabulary learning have been done in L1 and ESL students (Silverman & Hines, 2009). Silverman and Hines (2009) evaluate vocabulary learning in L1 and ESL children from pre-kinder to second grade. In their study, oral in-classroom reading was complemented with multimedia by presenting students with videos related to the reading topics during a twelve-week intervention. The study sample consisted of 85 children distributed among pre-kindergarten (15), kindergarten (28), first grade (25), and second grade (17). Using a parent's questionnaire children were classified as L1 or ESL. The final sample consisted of 32% ESL and 68% L1. L1 students and ESL students were divided into two groups each for a total of four groups (2 of L1 students and 2 of ESL students). Within the pairs of groups, there was an enhanced multimedia group—which read stories for two days and, in the third day, watched videos related to the stories—and a nonmultimedia group—which read stories for three days and did not have access to the videos. Silverman and Hines did not find significant statistical differences between the results for both L1 children groups. However, in the ESL children groups a positive and significant statistical effect was observed between the multimedia enhance group and the nonmultimedia group. For example, under the nonmultimedia condition nonESL gained the same number of points from pretest to posttest as nonESL in the media condition. Conversely, ESLs in the multimedia condition gained about 17 points, whereas ESLs in the nonmultimedia condition gained only about 11 points from pretest to posttests. The

researchers believed L1 children had the necessary tools at this level to learn effectively with and without the video support. However, the ESL children might acquire some of these tools through video interaction. It may appear that these videos helped fill the gap many ESL children have due to their poor exposure to English in their immediate home environments. Nonetheless, the authors of this study do not explain the English background of the children participating in the study. Additionally, this study needs repetitions due to design issues in terms of sample size and language assessment tools.

Chai and Erlam (2008) observed similar results with 20 college students who were native Chinese speakers learning English as a second language. The sample's average age was 22 and it was randomly divided into two groups. One group saw videos with captions and the other group without captions. Chai and Erlam wanted to find whether the combination of video and caption might lead to better learning and retention of vocabulary and phrases. Furthermore, Chai and Erlam wanted to explore if the inclusion of captions influenced students attention toward any of the multimedia elements (caption, sound, or picture). Although no statistical significant difference was found, students in the caption group scored higher on the reading comprehension assessment than those in the noncaption group. Students reported that their attention shifted significantly to the captions because this element helped them understand the narration and the relation among images better. Chai and Erlam (2008) study supported the value of integrating additional multimedia helpers.

Furthermore, Cohen and Johnson (2010) studied the acquisition of vocabulary by L1 learning Hebrew. The sample consisted of 15 students, which were assigned randomly

to three intervention conditions (word only with verbal presentation, picture paired with vocabulary word, and student creation of a mental image of the presented word and their drawing on paper of their mental image) (Cohen & Johnson, 2010). In general, Cohen and Johnson (2010) did not find statistical significance between the three interventions. Cohen and Johnson (2010) study had many limitations, such as the convenient sample, the sample size and the fact that the selected group was used to learning vocabulary because of their multilanguage education environment.

In a more specific study about effective combinations of learning objects in multimedia instruction, Mayer and Scott (2012) studied the effect of animated human-like pedagogical onscreen characters on college students learning processes in three different experiments. They wanted to study whether the use of learning agents with human-like characteristics have an influence in student learning outcomes. On the first experiment, eighty-eight college students from the Psychology Subject Pool at the University of California, Santa Barbara were recruited to participate in the study. Using a between-subjects design—where participants can be part of the treatment group or the control but not both—Mayer and Scott randomly divided the sample into three groups. One group had a high embodiment with human voice, a second group had a low embodiment with human voice, and the third group did not have an onscreen agent with human voice. The difference in embodiment with human voice interaction was introduced to explore cognitive overload by this element. After the intervention, participants answered a questionnaire and completed a retention assessment tool in which they had to explain what they were supposed to learn (Mayer & Scott, 2012). The results

of this experiment showed that learners performed better in a transfer test when human-like agents were present. This is defined as the *embodiment effect* (Mayer & Scott, 2012). The *embodied effect* occurs when students learn better in the presence of human agents because interaction with the agents triggers a social element that causes students to work harder in making sense of the material (Mayer & Scott, 2012). However, a comparison between the low embodiment with human voice and the nonhuman element groups reflected no significant difference. Therefore, for these groups having the human element on the screen made no significant difference. On their second experiment Mayer and Scott wanted to study if the embodiment effect would be obtained independently of the type of voice the agent on screen used. One of the voices was a machine-synthesized voice and the other was a human voice. The assessment tools and the sample selection were the same as in the first experiment. However, this time Mayer and Scott had four treatment groups: high embodiment with human voice, low embodiment with human voice, high embodiment with machine voice, and low embodiment with machine voice. Mayer and Scott results in the second experiment showed that the high embodiment group significantly outscored the low embodiment group when the agent spoke in human voice but not when the agent spoke in machine voice. Mayer and Scott believed that the machine voice was a negative social agent that affected the positive impact of the human agent. Therefore, when considering this type of technology, one has to take into consideration not only the possible element of cognitive overload but also the negative social queues related to embodiment effects in computer technology. Nevertheless, in both experiments the embodiment effect was observed when the onscreen agents were

present and the students learned better in the multimedia presentation with an onscreen human-voiced agent.

To Lin and Tseng (2012) the question was which was more effective, pictures or videos, in learning difficult words. Their intervention consisted of three different approaches to access word definition on a digital short story. One group would access the definition only through text, a second group through both text and an image, and a third one through the combination of text and a related video or short animation. Their sample consisted of 88 seventh grade Chinese students learning English as a second language. In order to compare the three groups Lin and Tseng used two different instruments as pre and posttests. To access long-term learning, the posttest was administered twice, immediately after the intervention and two weeks after. In this study the text-video group outperformed the other two. Students not only reported having enjoyed more the learning process but also showed significant improvement in their reading comprehension compared to the text-only or text-image group. This study is different from the above because the best performing group actively decided whether or not to use the video associated with the lesson. In the studies presented above, participants passively received information and no active learning was integrated. In Lin and Tseng study the videos and images were not imposed in the learning process. On the contrary, students had the participatory role to decide whether to use or not the multimedia element and up to what degree they needed it. Therefore, an active role in the learning process was present during the intervention. Studies like this one look to combine multimedia technologies

effectively in order to maximize results and to understand the influence the role of the learner might have on the effectiveness of the technology.

Similarly, Jung Won and Suhyun (2012) wanted to explore how best to combine interactive whiteboards, podcast and digital storytelling to increase proficiencies on ESL learners. In addition, Jung Won and Suhyun wanted to understand how participants perceived the effectiveness of these technologies. They define an *interactive whiteboard* as a "touch-sensitive devise that allows users to interact with digital material" (Won & Suhyun , 2012, p.2). The integration of the three technologies was through the curriculum and the summer program, not exclusively in one type of intervention as in studies previously discussed. Jung Won and Suhyun developed a one-month intensive summer English program were students had to learn vocabulary related to the body, community, weather, and the world. Some of the activities used include reading, writing, and open discussions. The study was implemented as a summer program for Korean ESL learners in third and fourth grade that had less than a year living in the United States. The selection of the groups was strictly based on their teachers' experience integrating technology into their classrooms. The final sample consisted of 11 students with limited English proficiency. No comparison group was included on the study. The teacher used video podcast for students to review daily lessons and complete homework assignments. Each week students took a vocabulary pretest and at the end of the week they took a posttest. Additionally, students had to complete a digital story-telling project using the photo story program. Won and Suhyun found statistically significant improvement in vocabulary acquisition and English proficiency in the students expose to these

technologies. From the photo story assignment Jung Won and Suhyun concluded that students gained significant opportunities to practice their new language through researching, writing, and speaking. This study presented preliminary evidence that effective implementation of educational technology contributes to improve English skills in ESL learners. However, generalizations and causality effects of the implementation cannot be considered due to the methodology selected by Jung Won and Suhyun.

Another approach is to study asynchronous *Computer Assisted Language Programs* (CALL) as effective learning tools. Gorjian, Moosvaina, Kavari, Asgari and Hydarei (2011) study the efficiency of a CALL program to help ESL adults between the ages of 18 to 40 improve their English vocabulary acquisition and pronunciation. The CALL program allowed them to hear words pronunciation and observe images or videos related to the word definition. Adults using the CALL program showed a significant improvement in their English proficiency compared to groups not exposed to this program. In a similar approach, but considering the active role of the student in the learning process, Türk and Erçetin (2014) wanted to investigate the effects of student's active role in their process of selecting the multimedia technology to improve their reading comprehension and vocabulary learning. Türk and Erçetin believed that students with the opportunity to interact with the display condition would be more eager to participate because having control would increase their interest in learning content. The study was conducted with participants between 15 and 16 years old attending a high school in Turkey. This group of 82 students had been learning ESL for at least six years. Türk and Erçetin used reading text with multimedia glosses to track and record students'

interaction with the text, multiple-choice test to measure reading performance, and unannounced vocabulary test to measure incidental vocabulary learning. The results indicated that students exposed to the interactive display condition had less activity using the multimedia elements than the simultaneous group. The simultaneous groups accessed the multimedia resources more frequently and spent more time viewing them (Türk and Erçetin, 2014). Although both groups showed an improvement in their language skills while being in contact with the multimedia resources, the group that received, the verbal and visual information, had better performance.

The studies discussed present evidence of the possible effects adopting multimedia may have in learning, including in the study of vocabulary instruction. However, each has different targets in terms of the population studied, the developmental age of the population and their academic needs. The need to explore in more detail the use of multimedia in vocabulary learning for both L1 and ESL learners is clear. Furthermore, none of these studies significantly explores the use of these technologies by the student in the construction of meaning and the effect this active role might have in long-term vocabulary recollection. Nonetheless, the integration of these technological tools must go hand in hand with the existing theories about reading development, vocabulary acquisition and reading comprehension in L1 and ESL learners. The following section provides a general understanding of the development process of reading, vocabulary learning, and reading comprehension, in an attempt to better understand the scope of learning ESL for Spanish speakers and how to integrate

multimedia technologies to enhance this process. Pedagogical practices and other studies with ESL learners will be presented.

Current Study

Different approaches have been shown to be effective for improving vocabulary in L1 and ESL learners. However, there is a need for further research on which strategies using multimedia learning may be most effective to improve vocabulary learning in upper elementary and especially with ESL learners. The present study used a variation of Lesaux et al. (2010) Academic Language Instruction for All Students (ALIAS) instructional vocabulary program to incorporate multimedia-learning activities that foster children's active experiences with vocabulary. This variation pretends to answer two research questions using fourth to sixth grade native Spanish speakers as participants: 1) Does adding an active multimedia interaction component while linking the verbal code to the visual code increase vocabulary acquisition? 2) Will the selected variation produce generalized gains in reading comprehension?

Chapter 3: Research Method

Introduction

This chapter includes a detailed description of the methodology for this exploratory study. The purpose of this study was to examine how the interactive use of multimedia technologies could promote vocabulary acquisition and reading comprehension in Puerto Rican children from fourth through sixth grade who are learning ESL. Chapter 3 includes a description of the methodology. This chapter is divided into the following sections: (a) a description of the study design; (b) the methods for sample selection; (c) the sample size; (d) a brief description of the participants' demographics; (e) a description of the assessment instrument; (f) a description of the research question and hypotheses; (g) data analyses to test the hypotheses, and (h) a summary of the information presented in the chapter.

Research Design and Approach

The research design selected was a pretest-posttest design with control and treatment groups. Groups were randomly divided between those in a multimedia vocabulary intervention program and those learning the same vocabulary with traditional classroom practices. Within each of the groups, the school English teacher created three English levels: beginner, intermediate, and advanced. Students at the beginner level in the control groups and students at the beginner level in the treatment groups worked with the same readings and vocabulary and received the same pretest and posttest evaluations. The same procedure was executed with the intermediate and advanced students. All variables operating in each group and language level were identical except for the multimedia

vocabulary intervention program. Participants were similar in terms of academic achievement because the school did not assign groups based on students' academic performance. The school released the deidentified data set to me via a data use agreement.

Population

Juan Ponce De León School was the first public school in Puerto Rico to successfully implement Montessori methodology and educational philosophy at all academic levels. It has been a Montessori school for more than 10 years. It is located in an urban, small, low-income community called Juan Domingo. However, families in nearby wealthy communities can also send their children to the school. In this academic year (2015-2016), 51% of the total student population (331 students) lives below the poverty level. The Juan Ponce De León School actively participates in the formulation of public policy that supports the development of additional Montessori public schools around the island. At this community-based school, the majority of the children come from the Juan Domingo community or are the children of alumni. This has been an essential factor in the development of strong parental involvement in the school.

The school offers all Montessori levels, which are divided by age: 0–3 years (infant and toddler), 3–6 years (early childhood), 6–9 years (lower elementary), 9–12 years (upper elementary), and 12–15 years (middle school or *Erdkinder*). Each Montessori level is made up of several multiage classrooms, which include students from three academic grades. For example, the upper elementary level consists of four classrooms containing students of what are traditionally referred to as the fourth, fifth,

and sixth grades. All classrooms have about six to seven students of each academic grade, and the average classroom size is 22 students. Every classroom has a main teacher and a teaching assistant. Most of the lessons are given in small groups of students from the same academic grade; few are given to the whole classroom simultaneously. ESL education begins at the early childhood level, and there is one separate English teacher per level. The English teacher visits the classrooms during the day to teach small lessons and leave follow-up work. Commonly, English lessons last less than half an hour, and during the rest of the day lessons are given in Spanish.

Sampling and Sampling Procedure

The population under study was very specific: ESL learners from a public Montessori school in Puerto Rico. The only students who fit this description were those attending Juan Ponce De León School. The study sample consisted of children at the upper elementary level because it was expected that at this level, reading comprehension difficulties would be primarily related to vocabulary acquisition and not to decoding reading factors (Becker, 1977; Chall & Conard, 1991; Chall, Jacobs, & Baldwin, 1990; Francis et al., 2008; Lesaux & Kieffer, 2010; Silverman & Crandall, 2010; Snowling & Hulme, 2011). Therefore, the study sample was a convenience sample (Johnson & Christensen, 2008). As commented previously, this type of sampling presents the limitations of any nonrandom sampling method affecting the generalizability of the results.

Studies implementing vocabulary-learning strategies using technology with samples of between 30 and 90 participants have found significant differences between

control and treatment groups (Basoglu & Akdemir, 2010; Lan, 2013; Lin & Tseng, 2012). Cohen (1988) suggested that groups consisting of 30 participants for a medium to large effect size will lead to 80% power. In Juan Ponce De León School, there were 85 students at the upper elementary level between the ages of 9 to 12, distributed in four Montessori classrooms. Within each classroom, there were three academic levels: (a) fourth grade, (b) fifth grade, and (c) sixth grade. However, Montessori philosophy allows students within the same classroom to undertake work intended for any of the academic levels corresponding to the classroom. Commonly, students in an English course are distributed not according to their academic level, but according to their language level. The distribution of students per grade was 28 in fourth grade, 30 in fifth grade, and 28 in sixth grade. Students were assigned to these groups in their first year of upper elementary, and the distribution was not based on their academic performance. Therefore, groups were academically homogeneous. However, the English teacher divided all upper elementary students into three English levels: beginner, intermediate, and advance. Finally, to be considered eligible to participate in the study, children had to be active students at the upper elementary level at the selected school. Two of the school's upper elementary classrooms were assigned randomly to the multimedia English vocabulary intervention, while the other two classrooms received traditional assignments for learning English vocabulary.

Additionally, the school administration agreed to released deidentified data about the participants' current age, gender, family socioeconomic status, and English language

experiences outside the school environment. The deidentified test and demographic data were linked.

Intervention

The intervention consisted of an 8-week program conducted by the Juan Ponce De León upper elementary English teacher. Prior to the intervention, the school administered three reading comprehension maze cloze pretests to students in the control and treatment groups, one for each of the English language levels: beginner, intermediate, and advanced. At the beginning of each week, students read a short story related to their cultural studies curriculum and, guided by their teacher, discussed important concepts and identified key words. Then, students defined the concepts in their own words. Stahl and Nagy (2006) suggested that teachers assess students' understanding of definitions by making them restate concepts in their own words. During word definition, the teacher provided instruction in word form by teaching specific key suffixes, allowing students to figure out unknown words in a text by using word parts (Baumann et al., 2002; Lesaux et al., 2010). Key words were then defined and represented by the students. The treatment group defined words, demonstrated additional meanings, and practiced word morphology using multimedia technologies to create dictionaries that integrated pictures, audio, and text in a digital environment. The only difference between the treatment group and the control group was that the latter did not work with the multimedia technology.

Instrumentation and Materials

This study used reading comprehension pre- and posttests for the beginning and the end of the program, as well as sociodemographic deidentified data provided by the

school. The sociodemographic deidentified data provided by the school were linked to the pretest-posttest data.

Reading Comprehension Tests

To test reading comprehension, cloze tests were created. They presented students with one or more paragraphs in which some words were systematically omitted. These omissions needed to be supplied by the reader using syntactic and semantic keys obtained from the text (Condemarin & Milicić, 1988). Through this reading comprehension testing procedure, the reader was required to interact with the text as active readers searching for meaning. Therefore, in order to comprehend and fill in the missing words, students had to focus their attention on the processing of contextual codes (Condemarin & Milicić, 1988). There are multiple variations of the cloze test, such as the maze cloze, cloze with pairing, cloze with helping keys, cumulative cloze, and oral postreading cloze (Condemarin & Milicić, 1988). The maze cloze test includes several words from which the reader must choose in order to fill in the blanks in a paragraph. Three words are included under a blank space; only one is suitable for filling in the blank, and the other two are used as distractors. The student selects one word and places it in the blank. Take, for instance, the sentence "Since the $_{\text{(yard, living room, bathroom)}}$ tends to be humid after bathing and showering, it's a likely place to find them." In this example, the student has to choose between the words *yard*, *living room*, and *bathroom*.

Baldauf and Propst (1979) claimed that maze cloze is a valid and reliable measure for assessing reading comprehension in ESL students. McGraw (2006) found that the maze measure is a useful reading comprehension instrument for upper elementary

students. Therefore, a maze instrument was created and used as a measure of reading comprehension in this study.

A team of authors created the reading passages for the maze cloze tests. Story ideas were provided to these authors. The ideas provided to the authors related to a topic studied in the curriculim of the upper elementary Montessori school. The criteria used for the passages' creation were selected from McGraw (2006). These criteria are presented in Table 1 and take into account students' academic level.

Table 1

Criteria for Maze Cloze Passage Creation

1. Passages should have a beginning, middle and end.
2. Use proper names sparsely and carefully.
3. Passages should be engaging in the first paragraph.
4. Avoid lists of things.
5. Passages should be sensitive and respectful to all groups and subgroups.
6. Passages should be grammatically correct with mature phrasing and convectional sentence structure.
7. Passages should flow rather than be abrupt.
8. Passages should be gentle, positive, and friendly, modeling pro-social behaviors.
9. Passages should include issues of diversity in terms of socioeconomic factors, disability, race, ethnicity, family, structures, background, and culture.
10. A mixture of 60% expository and 40% narrative passages.

Note. From *Identifying Valid Measures of Reading Comprehension: Comparing the Validity of Oral Reading Fluency, Retell Fluency, and Maze Procedures* (Doctoral dissertation), by K. A. McGraw, 2006, available from ProQuest Dissertations & Theses Full Text database. (UMI No. 305274240)

The readability levels of the passages used in the maze cloze instruments were measured using the Simple Measure of Gobbledygook (SMOG) readability calculator. Based on the McGraw (2006) study, the readability criteria for beginner-level English students in SMOG is 8.3. For students at the intermediate and advanced levels, it is 8.9.

Demographic Information

English proficiency is highly influenced by socioeconomic variables and home language experiences (Dixon, Wu, & Daraghmeh, 2012; Garnett, 2010; Tseng, Tsai, & Chao, 2013). Thus, the school provided sociodemographic information. This information reflected variables such as gender, age, socioeconomic status, and English language experiences in the school environment.

Definition of Operational Measures

Nachmias and Nachmias (2008) described operational definitions as forming connections between theoretical concepts and the empirical level. Operational definitions become measurements when researchers can assigns numerals (numbers or symbols) to variables according to prescribed rules (Nachmias & Nachmias, 2008). In this study, I wanted to determined whether the multimedia vocabulary intervention had an impact on the students' maze cloze test scores. Therefore, the independent variable in this study was the vocabulary intervention program, which was designed but not implemented by the me. The dependent variable was children's reading comprehension ability, measured with a cloze test before and after the children's completion of the intervention program. The intervention condition involved a Montessori approach whereby students created multimedia dictionaries to learn new vocabulary words. The dependent variables were

measured by changes in students' scores on the pre and post maze cloze vocabulary tests that were administered by the school during this study. The school released the deidentified data set for the pre and posttest results to me via a data use agreement.

The potential intervening variables included socioeconomic level and the level of exposure to the English language that students had at home by watching television, interacting with video games, or speaking with their parents. The school gathered this information through forms parents had to complete at the beginning of each academic year. In addition, parents' or teachers' assistance in the construction of the multimedia dictionaries might have had an impact on both the independent and the dependent variable. Finally, although the school population came mainly from the low-income Juan Domingo Community, there were upper class communities close to the school. Garnett (2010) found that English proficiency is highly influenced by students' ethnographic background and socioeconomic status. Therefore, a demographic variable such as family income may have influenced the outcomes.

Data Collection and Analysis

In the study setting, all students received their English instruction from the same teacher. This teacher administered the maze cloze pretests to both the control and treatment groups at the beginning of the research and the same test at the end of the 8-week intervention program. The results of the pretest and posttest of the treatment and control groups were compared using self-paired *t* tests. The pretest data acted as a covariate that adjusted the posttest data so that they reflected more accurately the effect of the treatments.

The final samples of the study consisted of 44 students in the control group and 41 students in the treatment group. Therefore, a normal curve will not approximate the sampling distribution of the difference between means, and inaccurate conclusions could be obtained (Nachmias & Nachmias, 2008). In this case, Nachmias and Nachmias (2008) recommended the sample distribution *t.* The data from the maze cloze tests were obtained in percentages. Therefore, the data were transformed with arcsine transformation to stabilize the variances prior to the statistical analysis. For reporting purposes, the data were returned to they original scale. A *t* test was used to compare the pretest and posttest means of the treatment and control groups to determine the effectiveness of the multimedia vocabulary intervention with a significance level of $p < .05$. If the pretest and posttest differences had been significant, then an ANCOVA analysis would have been executed. The ANCOVA analysis would have been used to determine whether there was a statistically significant difference between the treatment group and the nontreatment group. In turn, if there had been a statistically significant difference between the two groups, an effect size would have been reported. It has been suggested by Huttema (2011) that, for the sake of clarity, effect size should be a standardized effect size.

Protection of Human Participants

For this study, participants interacted only with their English teacher. The teacher was in charge of the implementation of the intervention and the tests. I had no direct contact with the children. All test results were confidential, with serial codes used to avoid identification of the participants. In addition, all of the data collected were kept in a secure place with limited access for the general public in order to assure confidentiality. I

ensured that no participant could be identified and used a database containing deidentified individual student data only for research purposes. Finally, the data were not sold, exchanged, or altered partially or completely under any circumstances.

Chapter 4: Results

Introduction

This chapter includes the results of the study. First, a detailed description of the data collection parameters is provided. Then, the process of data screening and preparation is described, followed by a presentation of the demographic characteristics of the final samples and a summary of the data analysis of the pretest and posttest scores.

Purpose and Problem

The purpose of this study was to examine the effect of multimedia technologies on vocabulary acquisition and reading comprehension in ESL upper elementary children. Although multimedia technologies have proven to be effective educational tools for language and information acquisition, most of the studies supporting their use have been conducted at the university level and have required a passive role for the student (Chai & Erlam, 2008; Cohen & Johnson, 2010; Farley et al., 2012; Mayer & Moreno, 2003; Rosen et al., 2012; Schwartz, 2005; Silverman & Hines, 2009). The literature review demonstrated that there is little evidence of the effect that multimedia technology use might have on the acquisition of vocabulary over the short and long term. Furthermore, the literature has not addressed whether an active role while using this technology might increase students' learning results and ultimately reading comprehension.

Research Questions

This study addressed two research questions. The first question involved testing whether the use of multimedia technology would have an effect in the processing of new vocabulary. It was presumed that the use of interactive multimedia technologies would

result in an increase of deep processing of new vocabulary in ESL upper elementary children. The second research question involved the exploration of whether the interaction of the students with new vocabulary through the use of multimedia technologies would contribute to increases in their reading comprehension capacity. It was assumed that ESL upper elementary children's reading comprehension capacity would increase as a result of their active interaction with multimedia technologies to learn vocabulary.

Data Screening and Preparation

The administration of the Juan Ponce de León Montessori School agreed to implement the multimedia program in the school's four upper elementary classrooms as part of their yearly English learning program. In this school, upper elementary students receive English instruction from the same teacher. For this study, the teacher divided students in each classroom into three English levels: beginner, intermediate, and advanced. Afterward, the English teacher randomly assigned two of the four classrooms to the treatment group and the other two to the control group. The English teacher administered the maze cloze pretests for each English level (i.e., one for the beginner English level, a second one for the intermediate English level, and another for the advanced English level) to students from both the control and the treatment groups during the beginning of the research period and administered the same test again at the end of the 8-week intervention program. The school electronically released deidentified test results in addition to students' deidentified demographic information. Subjects were eliminated from the data set if they did not take one of the tests (pre- or posttest). The

upper elementary classrooms consisted of 86 students. The final data set had a total of 85 subjects. The distribution of the subjects by English level was 28 at the beginner level, 39 at the intermediate level, and 18 at the advanced level. The beginner level had 13 subjects in the control group and 15 in the treatment group, and the intermediate level had 20 subjects in the control group and 19 in the treatment group. The advanced group had 8 subjects in the control group and 10 in the treatment group (see Table 2).

Table 2

Final Distribution of Subjects

	Beginner	Intermediate	Advanced	Totals
Control	13	20	8	41
Treatment	15	19	10	44
Total	28	39	18	85

Intervention Fidelity

The intervention consisted of an 8-week program conducted by the upper elementary English teacher at the Juan Ponce de León School. The teacher divided students into three English language levels: beginner, intermediate, and advanced. Then he picked two classrooms randomly to participate in the multimedia intervention, with the other two participating in regular Montessori vocabulary learning practices. Students were expected to work with the selected vocabulary every week. However, during the 8-week program, the students delayed their work and did not reach the expected vocabulary goals. Therefore, the students engaged in less vocabulary practice than expected. This might have had a negative effect on the study results.

Study Results

The study results are divided among the three English levels into which students were divided (beginner, intermediate, and advanced). Demographic information about the students was supplied by the school for each of the English levels.

Beginner ELL Sample

Demographics. The beginner ELL sample consisted of 28 students, 14 males (53.8%) and 12 females (42.9%). No gender information was available for two of the students in this group. The students ranged in age from 8 years (3.6%) to 14 years (3.6%) with a standard deviation of 1.190. The average age for the sample was 10. Many of the parents and guardians of the participating students reported a high school diploma (28.6%) or an associate degree (17.9%) as the highest level of education. For the majority of the students (86%, $n = 24$), Spanish was the first language spoken at home. However, 64% ($n = 18$) of parents and guardians described their children's level of exposure to English outside school as between intermediate and high. This exposure was attributed mostly to watching television and playing video games.

Paired *t* tests. The paired *t* test was conducted to determine if there was a difference in results between the pretest and the posttest for the treatment group and the control group. The mean difference for the experimental group was -.334 in favor of the posttest results. However, a confidence interval of 95% for the means differences resulted in a probability value of .74 or 74% (greater than .05) with a range of differences between -.08673 and .06365 in favor of the posttest results. Therefore, the observed differences between the results in the pretest and posttest for the treatment group were not

statistically significant for a *p* value of 5%. Similarly, the mean difference for the control group was .565 in favor of the posttest results with a probability value of .58 or 58% (.58 ≥ *p* = .05) and in a range of differences between -.17511 and .10511 in favor of the posttest results. Consequently, the observed differences between the results in the pretest and posttest for the control groups were not statistically significant for a *p* value of 5% (see Table 3).

Table 3

Result of Control vs. Experimental Groups, Beginner ESL Level, n = 28

Group	Mean (*SD*) pretest	Mean (*SD*) posttest	Statistic (*p*-value)
Treatment	.4538 (.09233) *n* =13	.4654 (.10284) *n* =13	*t* = -.334; (.74)
Control	.4550(.12791) *n* =10	.4900 (.18379) *n* = 10	*t* = -.565; (.58)

Independent samples *t* tests. The independent sample *t* test was conducted to determine whether the difference between the means of the treatment and control groups was statistically significant. The mean difference on the pretest was .025. A confidence interval of 95% for the means differences resulted in a probability value of .568 or 56.8% (greater than .05). Equal variances was assumed (Levene's test for equality of variances had a significance of .379), and the range of differences was between -.064 and .113. The observed differences between the results in the pretest for the treatment and control groups were not statistically significant for a *p* value of 5%. The mean difference on the posttest was .025, resulting in a probability value of .710 or 71% (.71 ≥ *p* = .05) and in a range of differences between -.115 and .164. Equal variances were not assumed

(Levene's test for equality of variances had a significance of .036). Consequently, the observed differences between the results in the treatment and control groups for the posttest were not statistically significant for a *p* value of 5% (see Table 4).

Table 4

Result of Control vs. Experimental Groups, Independent Sample Test of the Beginner ESL Level

Group	Mean (*SD*) pretest	Mean (*SD*) posttest
Treatment	.44 (.090) *n* = 15	.47 (.103) *n* = 13
Control	.47 (.129) *n* = 11	.49 (.184) *n* = 10
Statistic (*p*-value)	*t* = .579; .568	*t* = .380; .710

Intermediate ELL Sample

Demographics. The intermediate ELL sample consisted of 39 students, 12 males (30.8%) and 24 females (61.5%). No gender information was available for three of the students in this group. The students ranged in age from 9 years (15.4%) to 11 years (33.3%) with a standard deviation of 0.719. The average age for the sample was 10 years. Parents and guardians reported the following for highest level of education: high school diploma (10.3%), associate's degree (25.6%), bachelor's degree (23.1%), and master's or doctoral degree (23.1%). The majority of the students 74.4% (*n* = 29) had Spanish as

their first language spoken at home. However, 74% (n = 28) described their children's exposure to English outside school as between intermediate and high. This exposure was attributed mostly to watching television and playing video games.

Paired *t* tests. The mean difference on the experimental group was -.11754 in favor of the posttest results. A confidence interval of 95% for the means differences resulted in a probability value of .013 or 1.3% (.013 ≤ p = .05) with a range of differences between -.20725 and -.02783 in favor of the posttest results. Therefore, the observed differences between the results in the pretest and posttest for the treatment group were statistically significant for a p value of 5%. However, the mean difference on the control group was -.05561 in favor of the posttest result, although with a probability value of .076 or 7.6% (0.076 ≥ p = .05) and in a range of differences between -.11772 and .00650 in favor of the posttest results. Consequently, the observed differences between the results in the pretest and posttest for the control groups were not statistically significant for a p value of 5% (see Table 5).

Table 5

Result of the Control vs. Experimental Groups, Intermediate ESL Level, n = 39

Group	Mean (*SD*) pretest	Mean (*SD*) posttest	Statistic (*p*-value)
Treatment	.5815 (.21977) n = 19	.6990 (.20550) n = 19	t = -2.753; (.013)
Control	.6000 (.25742) n = 20	.6556 (.19704) n = 20	t = -1.874; (.076)

Independent samples *t* tests. The mean difference on the pretest was .01854. A

confidence interval of 95% for the means differences resulted in a probability value of .811 or 81.1% (greater than .05). Equal variances were assumed (Levene's test for equality of variances significance was .686), and the range of differences was between -.13715 and .17423. The observed differences between the results in the pretest for the treatment and control groups were not statistically significant for a *p* value of 5%. The mean difference on the posttest was -.04339 in favor of the treatment group and resulting in a probability value of .505 or 50.5% (.505 ≥ *p* = .05) and in a range of differences between -.17400 and .08721. Equal variances were assumed (Levene's test for equality of variances significance was .884). Consequently, the observed differences between the results in the treatment and control groups for the posttest were not statistically significant for a *p* value of 5% (see Table 6).

Table 6

Result of the Control vs. Experimental Groups, Independent Sample Test of the Intermediate ESL Level

Group	Mean (*SD*) pretest	Mean (*SD*) posttest
Treatment	.5815 (.21977) *n* = 19	.6990 (.20550) *n* = 19
Control	. 6000 (.25742) *n* = 20	.6556 (.19704) *n* = 20
Statistic (*p*-value)	*t* = .241; .811	*t* = -.673; .505

Advanced ELL Sample

Demographics. The advanced ELL sample consisted of 18 students, 9 males (50.0%) and 8 females (44.4%). No gender information was available for one of the students in this group. The students ranged in age from 9 years (5.6%) to 12 years (11.1%) with a standard deviation of 0.752. The average age for the sample was 11 years. The parents and guardians reported the following for highest level of education: associate's degree (22.2%), bachelor's degree (38.9%), and master's or doctoral degree (22.2%). The majority of the students 94.4% (n = 17) had Spanish as their first language spoken at home. However, 78% (n = 14) described their children's exposure to English outside school as between intermediate and high. This exposure was attributed mostly to watching television and playing video games.

Paired *t* tests. The mean difference for the experimental group was -.01000 in favor of the posttest results. A confidence interval of 95% for the means differences resulted in a probability value of .621 or 62.1% (.621 ≥ p = .05) with a range of differences between -.06194 and .04194 in favor of the posttest results. Nevertheless, the observed differences between the results of the pretest and posttest for the treatment group were not statistically significant for a p value of 5%. Similarly, the mean difference for the control group was -.04000 in favor of the posttest results, although with a probability value of .099 or 9.9% (0.099 ≥ p = .05) and in a range of differences between -.09194 and .01194 in favor of the posttest results. The observed differences between the results in the pretest and posttest for the control groups were not statistically significant for a p value of 5% (see Table 7).

Table 7

Result of the Control vs. Experimental Groups, Advanced ESL Level, n = 18

Group	Mean (*SD*) pretest	Mean (*SD*) posttest	Statistic (*p*-value)
Treatment	.8200 (.10368) *n* = 5	.8100 (.11402) *n* = 5	*t* = -.535; (.621)
Control	.5815 (.17819) *n* = 5	.7000 (.21506) *n* = 5	*t* = -2.138 (.099)

Independent samples *t* tests. The mean difference on the pretest was -.004. A confidence interval of 95% for the means differences resulted in a probability value of .961 or 96.1% (greater than .05). Equal variances were assumed (Levene's test for equality of variances significance was .644), and the range of differences between -.200 and .191. The observed differences between the results in the pretest for the treatment and control groups were not statistically significant for a *p* value of 5%. The mean difference on the posttest was -.110 in favor of the treatment group and resulting in a probability value of .342 or 34.2% (.342 ≥ *p* = .05) and in a range of differences between -.361 and .141. Equal variances were assumed (Levene's test for equality of variances significance was .063). Consequently, the observed differences between the results in the treatment and control groups for the posttest were not statistically significant for a *p* value of 5% (see Table 8).

Table 8

Result of the Control vs. Experimental Groups, Independent Sample Test of the Advanced ESL level

Group	Mean (*SD*) pretest	Mean (*SD*) posttest
Treatment	.74 (.168) *n* = 7	.81 (.114) *n* = 5
Control	.73 (.181) *n* = 8	.70 (.215) *n* = 5
Statistic (*p*-value)	*t* = -.049; .961	*t* = -1.010; .342

Summary

The purpose of this study was to explore the contribution active use of multimedia technologies could have in vocabulary acquisition and subsequently reading comprehension in children from fourth through sixth grade learning English as a second language. The results demonstrated only a statistical significance of an increase in student's new vocabulary and reading comprehension for the treatment intermediate level ESL group. However, when compared to the control group of this same level, no significance was found. Therefore, there is no enough evidence to demonstrate that this improvement in the treatment group was a result of the intervention. The intermediate group was the biggest sample, consisting of 39 students. The rest of the samples consisted of less than 30. It is likely that sample size created a trend toward significance. Therefore, in order to attain significance, a bigger sample should be considered.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

Purpose and Nature of the Study

The purpose of this study was to investigate whether taking an active role in using multimedia technology to construct word meaning would enhance students' vocabulary learning and reading comprehension at the upper elementary levels. Students were able to construct word meaning using a combination of words, images, audio, and video in a digital environment. The vocabulary selected was related to the topics studied in the rest of the content areas such as social studies, geography, or biology. Vocabulary acquisition and reading comprehension were measured by pre and post maze cloze tests that included several words from which the student had to choose in order to complete a sentence.

Through this study, I attempted to demonstrate that when students have the opportunity to use multimedia resources actively in their ESL learning process, academic results are enriched. The supposition was that the simultaneous combination of images, sounds, and text in a digital environment would allow students to have multiple references to the word. Learning depends on the effective interaction between long- and short-term memories (Lohr & Gall, 2008); therefore, it was assumed that having multiple references to a word would allow learners to access meaning more effectively. Likewise, it was expected that multiple references to words combined with an active learner role would increase ESL students' short- and long-term learning capacity for the vocabulary.

In summary, the study was design to demonstrate the impact of combining active learning with multimedia technology to increase vocabulary acquisition and reading comprehension.

Summary of Key Findings From the Study

Two questions were explored in this study. The first question was the following: Can the use of interactive multimedia technology (integration of picture, audio, and text in a digital environment) by ESL upper elementary children increase deep processing of new vocabulary (measured by application of new vocabulary in multiple contexts)? The second question addressed the possibility of increasing students' reading comprehension capacity: Can ESL upper elementary children's active interactions with multimedia technologies for vocabulary learning contribute to increasing their reading comprehension capacity? The following hypotheses were presented with these questions.

- *Null Hypothesis to RQ1*: Interactive multimedia technologies will have no significant effect on ESL upper elementary children's deep processing of new vocabulary when compared with their current classroom learning practices.
- *Alternate Hypothesis to RQ1*: ESL upper elementary children's use of interactive multimedia technologies will result in an increase of deep processing of new vocabulary when compared with their current classroom learning practices.
- *Null Hypothesis to RQ2*: ESL upper elementary children's active interactions with multimedia technologies for vocabulary learning will make no

statistically significant contribution to increasing their reading comprehension capacity.

- *Alternative Hypothesis to RQ2*: ESL upper elementary children's active interactions with multimedia technologies to learn vocabulary will make a statistically significant contribution to increasing their reading comprehension capacity when compared with their current classroom learning practices.

This research project found no significant impact of the multimedia treatment on the dependent variable identified for this study. There was no differential effect on the results from the reading comprehension tests for those students who had access to multimedia tools versus the control students who used traditional Montessori vocabulary learning strategies. Therefore, the null hypothesis for each research question could not be rejected. There was no significant difference between the treatment and the control groups' performance in relation to ESL upper elementary children's deep processing of new vocabulary and reading comprehension when compared with their current classroom learning practices.

It appears that the decision to divide the original sample of students into three groups according to their level of English had a significant impact on the results obtained in this research project by substantially reducing the statistical power of the study's sample. The original design determined that because each classroom had about six to seven students of each academic grade and the average classroom size was 22, the sample would consist of 88 participants, 44 control and 44 treatment. It was assumed that with these sample sizes, it would be possible to obtain significance differences among the

control and treatment groups, given that studies in the literature that involved implementing vocabulary-learning strategies using technology with samples of between 30 and 90 participants had found significant differences among the control and treatment groups (Basoglu & Akdemir, 2010; Lan, 2013; Lin & Tseng, 2012). However, the school's English upper elementary teacher implemented this study, and he decided to divide all upper elementary students into three English levels (beginner, intermediate, and advanced), resulting in a significant reduction of the sample sizes. Originally, the study projected a control sample and an experimental sample independent of the students' grade or English level. This was due to the fact that Montessori classrooms are multiage, allowing students to learn at different speeds in the same environment. The subdivision of the original experimental sample into three groups resulted in smaller sample sizes (15 in the beginner level, 19 in the intermediate level, and 10 in the advanced level). This action had the same effect in the control group, where the beginner-level sample had 13 students, the intermediate-level sample had 20 students, and the advanced-level sample had eight students. In addition, students failing to take the posttest further reduced the sample sizes. Therefore, at the end, this study involved 85 upper elementary children divided into three English levels: beginner (n = 28), intermediate (n = 39), and advanced (n = 18).

The school supplied demographic information about the students from each English level. This information showed that the three English levels were very similar in terms of variables such as parental education and language exposure. Parental education is a socioeconomic factor that has been consistently shown to predict academic outcome

for both ESL learners and native English speakers (Neuman, 2008). In all three English levels, most students' parents reported a bachelor's degree or higher as their highest level of education. The advanced English level had the highest level of parental educational attainment, with 73% of parents holding a bachelor's or higher degree. However, there is evidence that intensive literacy programs can reduce the effect of socioeconomic factors on students' academic outcomes and even gradually make them disappear (D'Angiulli, Siegel, & Maggi, 2004). Similarly, the language used at home, or *home language*, is related to literacy development in both ESL learners and native English speakers (Howard et al., 2014). The first language spoken at home by the vast majority of students who participated in the study was Spanish. In the beginner group, 88.9% of the sample spoke only Spanish at home, while in the intermediate group, the percentage was 80.5% and in the advanced group it was 100%. Although for the majority of the children participating in this dissertation study the home language was Spanish, parents described their children's exposure to English outside school as intermediate to high (66%). The most common sources of out-of-school English language exposure for the three English levels were video games, television, and music.

Interpretation of the Findings

Findings and the Literature

Although this study did not generate significant results for the multimedia vocabulary intervention program, students showed a small improvement in reading comprehension. Furthermore, in one of the samples, this improvement was statistically significant. Similar results were found in a study of ESL learners by Lesaux et al. (2010)

when using depth vocabulary and words with high academic utility. Both Lesaux et al. (2010) and Rosen et al. (2012) studied the active role of students in learning and showed that the integration of multimedia elements into the process had positive outcomes, although with no significant results. The primary causes for the lack of significance in both of these studies were sample sizes and the measurement instruments used.

In this study, the findings generated from the results of the pre- and posttests in the intermediate treatment group demonstrate that there is a positive effect in the use of educational technologies to maximize students' outcomes in learning vocabulary and subsequently in their reading comprehension capacity. The mean difference between the pre- and posttest for this group resulted in a probability value of .013. Moreover, the mean difference between the pre- and posttest for the intermediate English level control group resulted in a probability value of .076. These results confirm that when students learn vocabulary in context (Mancilla-Martinez & Lesaux, 2010) and use multiple sources of storage, their learning results are increased (Farley et al., 2012).

Analysis and Interpretation of Findings

The empirical analysis of the results revealed that students who used multimedia technology to actively interact with vocabulary did not obtain better results, on average, than those participating in regular vocabulary activities. For each of the treatment samples, when the results were compared with those of the corresponding control groups, no significant results were observed. The differences observed between the results in the posttest for the treatment and control groups resulted in higher probability values in favor of the null hypothesis (beginner samples $.71 \geq p$; intermediate samples $.505 \geq p$;

advanced samples .342 ≥ *p*). Therefore, a significance claim cannot be made for the treatment samples when compared to the control samples.

Only one sample showed a statistically significant improvement when compared with the pretest results. This sample was the English intermediate treatment group. When compared to results before the intervention, the English intermediate treatment group demonstrated a significant impact on vocabulary learning and reading comprehension. The mean difference between the pre- and posttest results in the treatment sample at the intermediate English level was -.11754 with a probability value of .013 or 1.3%. Therefore, in the English intermediate treatment group, students improved their vocabulary knowledge and English comprehension after their participation in the multimedia vocabulary program. However, when the results for the English intermediate treatment group were compared to the results for the English intermediate control group, the differences increased, although not enough to reach statistical significance. The mean difference between the treatment and control group in the pretest was .01854 with a probability value of .811 or 81.1%. The difference in the posttest increased to -.04339 in favor of the treatment group; however, the probability that the multimedia intervention did not affect students' reading comprehension remained elevated (.505 ≥ *p*). This result suggests that the observed impact of the intervention in the English intermediate treatment group cannot be entirely attributed to the multimedia vocabulary program.

Nevertheless, studies with strong sample sizes and similar methodological approaches (Farley et al., 2012; Lesaux et al., 2010; Rosen et al., 2012; Silverman & Hines, 2009) have also found low or no significance. Among the factors used to explain

this fact were the instruments used to measure the study variables (Lesaux et al., 2010) and the studies' sample sizes (Farley et al., 2012; Silverman & Hines, 2009).

However, there have been studies in which significance has been observed, which have shown a positive improvement in ESL learners using technologies for multisensory vocabulary learning (DiGregorio & Sobel-Lojeski, 2010; Kuo, Yu, & Hsiao, 2013; López, 2010; Wang, 2011). López (2010) found that ESL learners participating in digital learning classrooms increased their academic achievement when compared to ESL learners in traditional classrooms. Kuo, Yu, and Hsiao (2013) found significant differences between students learning ESL using multimodal presentation software integrated with an interactive whiteboard and those in regular classrooms. In these studies, ESL learners' vocabulary acquisition improved in comparison to their peers in regular classrooms. The main difference between these studies and the present dissertation study was the sample size. The sizes of the samples in this dissertation study were very low, and in some groups they were extremely low, $N \leq 5$ (Winter, 2013). The only group that showed statistical significance (intermediate-level English group) was the one with the larger sample size. Kuo, Yu, and Hsiao (2013) had a sample of 134 fifth graders, and López (2010) had a sample of 213 third graders and 151 fifth graders. Multiple methodologists recommend that researchers regard small sample sizes with caution because they usually imply low statistical power and therefore a high probability of rejecting a false null hypothesis (Cohen, 1970; Rossi, 1990). In addition, Siegel (1956) explained that some parametric tests, such as the *t* test, have critical assumptions that cannot be tested when the sample sizes are small.

In addition, this study was based on the recommendations and results of studies about learning vocabulary strategies for ESL learners and the use of educational technology in this process (Farley et al., 2012; Lesaux et al., 2010). Inability to extend the study for more than 8 weeks may have affected the students' learning curve in relation to technology use in the implementation. This would also have lessened the impact of the intervention. Moreover, because the study depended on secondary data, I did not have the opportunity to supervise the purity of the implementation process and the delivery of the pre- and posttests. I should have exercised greater control of the implementation process and should have insisted on making certain critical decisions, such as the choice to subdivide the samples, which resulted in very small groups.

Limitations of the Study

This study had several limitations that suggest future research directions. First, this study was conducted in a very specialized school setting, which significantly limited the ability to reproduce the results or to generalize the findings. Some of the school's particular characteristics were the use of Montessori methodology and philosophy, class size, and multiage organization of groups. The same study could be implemented in schools with the Montessori methodology or in nontraditional settings that support the active engagement of students in the learning process. Second, the school English teacher conducted the distribution of the study participants into English language levels, in addition to administering the pre- and posttests and performing corrections. I had no control over this process. Consequently, it was impossible to prevent the effect of variables that are known to influence students' performance when taking a test, especially

considering that the children in this school were not accustomed to test taking. Finally, the sample sizes of this study were low. Therefore, as stated before, some critical assumptions of the parametric *t* test could not be tested, and this increases the possibility of not rejecting a false null hypothesis.

Implications

The Juan Domingo community is a low-income community in one of the richest municipalities in Puerto Rico. Most of the students attending this school come from low-income households. Improving their ESL learning achievement could support their development and increase their academic and professional opportunities for the future. This type of intervention represents an opportunity for these students to be exposed to nontraditional learning experiences that broaden their understanding and provide them with additional learning alternatives. In addition, teachers' participation in these types of implementations can present them with many opportunities to update their knowledge of current methodological trends. Teaching English to ESL learners requires channeling instruction to pertinent areas where students are able to connect new knowledge more efficiently. This type of study offers teachers additional tools to practice differentiated education and may help students to acquire knowledge more effectively.

For future interventions of this nature, I would recommend ensuring that students have knowledge regarding computer use, Internet access, gathering data, and integration of audio and images. These technological skills and knowledge would improve students' success in using multimedia technology and, therefore, would increase the effectiveness of these tools. Similarly, teachers should be aware of the possible limitations and

challenges that technologies might pose to students in order to increase students' success in using these tools in their learning process (Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2009; Mouza, 2006; Wolff, 2008).

Conclusion

The major purpose of this dissertation was to demonstrate that technologies that are increasingly available to students have a positive impact in language acquisition. ESL learners at upper elementary confront the challenges of reading academic grade level texts without the vocabulary knowledge and reading comprehension proficiencies that are required. The results of this study showed that a multimedia technology approach positively contributes to reduce these challenges. However, these results were not supported by enough statistical significance and further research is required in order to determine the conditions in which such technologies can best promote the improvement of vocabulary acquisition and reading comprehension in upper elementary ESL learners.

Recommendations

This study examined the contribution that the active use of multimedia technologies can have in vocabulary acquisition and reading comprehension of ESL learners at a Montessori public school in Puerto Rico. No statistical significance was found in association with the impact of this intervention and the students learning achievements in vocabulary and reading comprehension. However, all the students improved their vocabulary acquisition and reading comprehension to some degree, and in the case of the intermediate treatment group this improvement had statistical significance. The study revealed that the use of pedagogical strategies, such as the use of multimedia

technologies, has a positive effect on the improvement of learning capabilities in ESL learners. Efforts to replicate this study using a multibaseline design that, through formative assessment procedures, establishes baseline performance across data series (Christ, 2007) could be helpful to ensure better result validity. Moreover, further studies should explore the experiences of teachers and students when working with multimedia technologies to learn new vocabulary. Moreover, further research should investigate the potential use of these technologies in other areas, such as writing and pronunciation in the context of ESL learners on elementary grade levels or in higher educational settings. Finally, it is important that future researchers gather a group of ELS learners more representative of the ESL learners in Puerto Rico, extending further the impact of their results.

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Appendix A: IRB Approval Number

The IRB approval number for this study is 10-21-15-0069115.