TEACHING MATH WORD PROBLEMS TO STUDENTS WITH LEARNING
DISABILITIES

A thesis submitted in partial fulfillment of the requirements for a
Master of Arts in Special Education
Mild/Moderate Disabilities

By

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Dedication

I’m dedicating my thesis to my future husband, Jonathan Mann-Krieger. He has helped me and supported me every step of the way from undergraduate school at CSUB to my master’s degree at CSUN. My life with him has been full of hope, joy, and love. I look forward to spending the rest of our lives together.

I would also like to acknowledge two former teachers of mine, Mr. and Mrs. Falk, whom I think about almost every day. They gave me the guidance and knowledge I needed in order to be a successful independent young adult. Mr. Falk relentlessly worked by my side when filling out college applications, financial aid, and with building the academic skills needed to attend college. He encouraged me to read an abundance of books and worked hard to get me into general education classes. He held high expectations for me, which in turn inspired me to strive for success. Thank you Mr. and Ms. Falk for giving me the support, direction, and knowledge I needed to accomplish my goals.

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ABSTRACT

TEACHING MATH WORD PROBLEMS TO STUDENTS WITH LEARNING DISABILITIES

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This thesis study examined the effectiveness of instruction teaching students with learning disabilities (LD) how to solve percentage word problems of varying types. Thirteen students with LD in grade seven participated in the study. Qualitative data were collected to determine if vocabulary instruction, self-regulation, and real-life connections (RLC) can improve the mathematical performance of students with LD. Results indicated self-regulation, coupled with RLC, is not an influential factor to improve mathematical performance of seventh grade students with LD, when other academic and linguistic variables are present. Implications of the study are discussed within the context of adopting an instructional program to assist English Language Learners (ELL) with accessing the general education curriculum, as well scaffolding techniques, to effectively apply self-regulation across academic area.
Mathematics is used throughout the world, and has been used for centuries to assist in all areas of daily life (Xin, Jitendra, & Deatline-Buchman, 2005). Knowledge and application of mathematics is a necessity for an individual to be successful in a literate society (Anzelmo-Skelton, 2006). The importance of mathematics literacy is a growing concern in the United States, and continues to pose challenges in the field of education. The National Center for Education Statistics (NCES, 2004, 2009) reported that 32% of eighth grade students in the U.S. scored ‘below basic’ on a mathematics-standardized test, which is constituted as significant understanding with solving whole numbers, decimals, fractions, and percents. In 2003, math achievement in the U.S. was lower than international students in 14 other countries (Little, 2009). Maccini, Mulcahy, and Wilson (2007) indicated U.S. students lag behind their international peers on math achievement tests due to deficiencies in higher-order thinking and application of real-world concepts.

Background of the Topic

Mathematics is often challenging for adolescent students with special needs. Several research studies have been conducted to investigate factors that contribute to the mathematical performance of students with and without learning disabilities (LD) at the secondary level (Acosta-Tello, 2010; Chapman, 2006; Elbaum, 2007; Little, 2009; Maccini et al., 2007; Strickland & Maccini, 2010; Xin et al., 2005; Xin, 2007;). These research findings suggest that mathematical performance is heavily linked to reading proficiency and instructional strategies as transferred to students with LD. This thesis
study was designed to investigate and identify effective instructional strategies that address the aforementioned components.

**Students with LD and Math Word Problems**

Given the difficulties experienced by students with LD at the secondary level, it is essential that an effective and efficient instructional approach be designed to assist students with mathematical problem solving (Maccini et al., 2007). This study is centered on teaching students with LD to compute mathematical word problems. According to Montague (2008), students with LD exhibit lower academic achievement than their non-disabled peers because of the higher order cognitive demands presented in mathematical problem solving. When solving word problems, students must be able to effectively identify the proper mathematical algorithm, compute the mathematical computation, as well as apply reading comprehension strategies to solve the problem. This is an extremely difficult task for students who have difficulty with attention and learning difficulties (Montague, 2007). In order for students to be successful with computing mathematical word problems, they must have a strong understanding of word knowledge (Sedita, 2005). Empirical research is inundated with studies that show a strong correlation between vocabulary knowledge and reading comprehension (Pierce & Fontaine, 2009; Sedita, 2005). Vocabulary instruction achieved through self-regulation should therefore be embedded within math lessons that are heavily comprised of word problems.

When teaching students with LD, it is necessary to take into account the cognitive characteristics of a student or population of students when determining an appropriate instructional strategy (Montague, 2008). Montague (2008) identified that students with
LD typically have severe challenges with regulating their own learning and need to be
given the tools to be successful when exposed to higher cognitive activities. When
reviewing the literature, several empirical articles addressed the positive effects of
improving mathematical achievement by means of self-regulation (Perels, Dignath, &
Schmitz, 2009). Strategies, such as self-questioning, self-evaluation, and self-
reinforcement, have proven to be effective tools which can help students direct their own
learning toward independent problem solving (Montague, 2008). Teaching students how
to regulate their own learning is a current trend in the field of education (Boekaerts &
Corno, 2005). This trend is attributed to the positive correlation between student
engagement and mathematical problem solving when applying self-regulatory strategies

Statement of the Problem

Due to recent federal education legislation, mathematic literacy is a fundamental
concern in the field of special education (Anzelmo-Skelton, 2006). The No Child Left
Behind Act of 2001 (NCLB) and the Individuals with Disabilities Education
Improvement Act (IDEIA) 2004 are mandated to improve the educational performance of
general and special education students. Both laws were designed to enhance student
progress with a heavy emphasis on accountability (Darling-Hammond, 2007; IDEIA).
Under IDEIA, students with disabilities are now required to meet “developmental goals
and, to the maximum extent possible, the challenging expectations that have been
established for all children”.

The NCLB education initiative focused on improving test scores ensuring highly
qualified teachers by the year 2014. Under NCLB (2001) and IDEIA (2004), students
with LD are required to have access to the general education curriculum, as well as participate in some form of statewide assessments to measure proficiency. Schools failing to make adequate yearly progress toward the annual score goal of the school are subject to specific sanctions or corrective actions, such as losing federal funding and being declared a failing school (Darling-Hammond, 2007). In this scenario, parents are allowed to remove their children at the school’s expense, which can result in schools being shut down (Darling-Hammond, 2007). As a result, a greater emphasis is placed on incorporating evidence-based practices within the classroom, which will enhance student performance in the likelihood that students with LD will meet proficiency on standardized assessments.

Several standardized assessments consist of mathematical word problems (Pierce & Fontaine, 2009) which require an increased demand on problem solving and higher-order conceptual thinking. The shift in student curriculum, in addition to high stakes standardized assessment, has changed instructional practices from procedural methods to conceptual learning (Little, 2009). Danesi (2007) noted that educators express high levels of frustration with teaching word problems in mathematics due to their students’ difficulties with grasping more difficult concepts, such as higher-order thinking and application of real-world concepts. During the last two decades, professional developments are addressing this growing concern, and are focusing on implementing methodologies that align with state and national standards (Downing, Earles-Vollrath, Lee, & Herner-Patnode, 2007).
Purpose of the Study

The intent of this thesis is to identify appropriate teaching methods to impart self-regulation as a tool for students with LD to solve math word problems. Since, mathematical word problems have proven to be problematic for many students, especially for students with LD (Chung & Tam, 2005). Several studies have been conducted to investigate factors that may contribute to poor mathematical performance. Geary (2004) focused on the effects LD have on the mathematical performance of secondary students. He concluded that students with mathematic learning disabilities (MLD) in the lower primary grades had average skills in number processing when compared to their typical-achieving peers. However, students with LD lacked conceptual understanding pertaining to counting principles in regards to arithmetic computation (Geary). His findings correlate with current empirical research, which states that students with LD have marginally developed metacognitive abilities (Montague, 2007).

Geary (2004) also identified that students with MLD frequently make procedural errors and struggle with retaining basic arithmetic facts. He also concluded students with MLD have cognitive delays which result in poor attention, poor associations, and difficulties with the language system. Geary provided insight to many of the challenges students with LD face when computing mathematical problems. Professionals in the field of education are attempting to identify instructional strategies and implement best practices to assist students with LD address their mathematical deficits.

According to Lager (2006), “Without a strong command of both everyday language and specialized mathematical language students cannot fully access the mathematics content of the text, lesson, or assessment” (p. 194). Empirical evidence has
shown students with a higher level of reading proficiency tend to be more successful in mathematical problem solving (Lamb, 2010), and that an effective vocabulary lesson must coincide with comprehension (McKeown & Beck, 2004). To assist with the comprehension of the meaning of words, students should have multiple forms of exposure to the new word being taught, a wide range of examples to learn the new word, and active engagement with applying the new word (McKeown & Beck). Learning new words in this manner will not only assist with comprehension, but enable students to feel more comfortable and confident with applying their new acquired vocabulary.

**Vocabulary Instruction**

The National Reading Panel (2000) found that there are several methodologies to teach vocabulary instruction, and that no one method is better than another as long as vocabulary is taught both directly and indirectly. Direct vocabulary instruction is when the teacher pre-selects the vocabulary words before a lesson (Pierce & Fontaine, 2009). Direct vocabulary instruction is a helpful tool to get students ready for an up-coming spelling test or to establish familiarity with the terms in an upcoming chapter. It is however, impractical to teach every word (McKeown & Beck, 2004), so it is important the pre-selected vocabulary is essential for comprehension in the classroom.

Another example of direct vocabulary instruction is breaking down a word to identify its roots, prefixes, and suffixes. This structural analysis is referred to as morphology, which is the process of breaking down a morphologically complex word into smaller units of meaning (Bellomo, 2009). For example, the word morphology can be broken down into two meaning units: “morph- meaning shape and –ology meaning study of” (Kieffer & Lesaux, 2007, p. 137). Kieffer and Lesaux revealed the
effectiveness of using morphology as an instructional vocabulary tool for the development of reading comprehension. Their study identified that a strong foundation of word meaning resulted in higher reading comprehension scores. They also concluded, however, that the study of “morphology is just one part of a comprehensive vocabulary and reading comprehension program” (p. 142). Teaching mathematics vocabulary to students with LD should be customized and tailored to address their individualized learning needs. The National Council of Teachers of Mathematics (NCTM) (2000) indicated a structural sequence in teaching mathematics should be present, as well as a pre-determined methodology and form of assessment to measure student progress.

**Self-Regulation**

Self-regulation strategies have been used in academic settings as self-management strategies that can assist with behavior, attention, emotional disabilities, and learning difficulties (Boekaerts & Corno, 2005). The aforementioned characteristics can be common issues among students with disabilities. Strategies such as self-questioning, mnemonic devices, and checklists have been used to assist students with monitoring their own learning and behavior (Montague, 2007). A proliferation of research studies has incorporated self-regulation strategies to improve student mathematical problem-solving for students with LD (Montague, 2007, 2008). Montague (2007, 2008) identified that students with LD face challenges regulating their own learning, and need to be taught explicitly how to cognitively regulate their own learning toward academic success. Montague (2008) examined seven studies, which incorporated self-regulation strategies as an instructional approach for mathematical problem-solving. She identified the cognitive demands self-regulation imposed on the participants of the studies and
recognized a correlation in enhanced mathematical performance. The aforementioned studies included self-regulatory strategies, such as a teacher generated checklist, to guide students toward independently solving math problems, an audio tone buzzer to cue students to monitor their own task behavior, as well as the incorporation of acronyms to assist students through complex algebraic problems (Montague, 2007).

**Learning Disabilities**

The purpose of this study is to examine the effect vocabulary, combined with self-regulation strategies, has on students with LD when computing mathematical word-problems. The classification of LD is often referred to as a specific learning disability (SLD), which is defined as “a disorder in one or more of the basic psychological processes” (IDEIA, 2004, sec. 300.8). A SLD is a neurological condition, which describes specific kinds of learning problems in the following areas: reading, math, speaking, reasoning, listening, and writing (David & Balakrishman, 2010). Identifying a student with a SLD can help parents and educators develop instructional strategies which meet the individualized needs of the student (David & Balakrishman, 2010).

**Eligibility for Special Education Services**

There are 13 eligibility classifications which determine if a child will receive special education services. The U.S. Department of Education determined that a child with a disability can fall into one or more of the following categories: autism, deafness, deaf-blindness, emotional disturbance, hard of hearing, mental retardation, multiple disabilities, orthopedic impairment, other health impairment, specific learning disability, speech and language, traumatic brain injury, and visual impairment (IDEIA, 2004, sec.
According to IDEIA, the previously mentioned disabilities must adversely affect a student’s educational performance in order to qualify for special education services (National Dissemination Center for Child with Disabilities, 2009). All students in the present study fall under IDEIA’s eligibility requirements. The findings of the current study, however, will focus primarily on the population of students with a SLD.

Research Question

The principle research question is: Can vocabulary instruction combined with self-regulation strategies assist seventh grade students with LD in developing problem solving skills to solve percentage word problems? A subordinate question is included to guide the research toward answering the principle research question: Can real life connections (RLC) assist seventh grade students with LD in obtaining a deeper understanding of percentage word problems?

Significance of the Study

Middle school mathematics results are noticeably deficient when compared to elementary mathematic results in the United States (Xin, 2007). Xin noted middle school mathematics instruction needs a considerable amount of attention because it establishes the foundation for academic success in high school and college. Five to eight percent of students with LD struggle with mathematics (Maccini et al., 2007). Higher expectations in mathematics instruction for students with LD will result in the academic gain necessary to be successful problem solvers. This thesis study will provide educators of students with LD at the seventh grade level with a potential intervention related to
vocabulary instruction and self-regulation strategies to remedy performance gaps in math word-problem proficiencies as mandated by NCLB and IDEIA.

**Limitations**

The participants in the study are students of the researcher. The researcher may indirectly have an effect on the participants’ behavior or may show an unbalanced amount of attention toward participants in the study. Student participation and level of engagement will also influence the amount of time and attention provided to each participant. The researcher attempts to engage all study participants, with limited results. This cannot be modified by the researcher, due to the students’ own personal behaviors, such as active participation or withdrawal.

**Delimitations**

Students categorized as English Language Learners (ELLs) are participants in the study, as enrolled students in this class, due to their additional categorization as LD. However, this ELL status and any modifications to teaching practices were not included in this study because not all the participants are ELLs. The common factor among all participants is their categorization as students with LD. In addition, it would have been inadvisable to exclude the English-only students from taking part in the study.
Chapter 2: Literature Review

For this study, the following key issues will be addressed in the literature review: (1) the correlation between reading proficiency and mathematical performance, and (2) math interventions which include vocabulary and self-regulation for assisting secondary school students with LD. The researcher begins by discussing the correlation between reading comprehension and mathematic problem solving. Secondly, the researcher reviews challenges students with LD face with computing mathematical word problems, which then segues into teaching methodologies that can assist with vocabulary development and arithmetic computation. The research goes on to investigate self-regulatory strategies as an aid to assist with vocabulary development. Lastly, the researcher addresses the use of real life connections (RLC) as a tool to assist with self-regulation and vocabulary comprehension. This chapter includes qualitative studies, case studies, document analysis, and a review of literature related to the present study.

Reading Comprehension and Mathematical Problem Solving

Research has indicated there is a correlation between reading comprehension and mathematic achievement (Acosta-Tello, 2010; Elbaum, 2007; Lamb, 2010; Xin, 2007). Math achievement tests are inundated with questions that require reading comprehension (Lamb). These examples pose difficulties for middle school students who are not proficient in reading due to their LD. Acosta-Tello analyzed the readability level of math word problems in various textbooks within the state of California to identify if the readability level was a contributing factor in academic performance. Acosta-Tello limited her research to the readability grade level of textbooks at fourth, sixth, and high school grade level algebra, as provided by state assessment reports in reading and
mathematics. However, this study did not address students with disabilities enrolled in math classes.

Three chapters were selected from each book and were analyzed using computer software. The software categorized the word problems into three different components: ease of readability, word and sentence length, and grade level. Acosta-Tello’s (2010) findings revealed that the textbook narratives were at, or below, grade level. Acosta-Tello furthered the study by analyzing the California Department of Education testing results. Data were collected from the Standardized Testing and Reporting Results (STAR) and used to determine student performance levels in reading and mathematics. The results indicated that 39% or more of the students in the aforementioned grades were not proficient in the language arts component on the statewide STAR exam. These findings suggest a large majority of students are reading textbooks and participating in state assessments which are beyond their grade level comprehension (Acosta-Tello).

A similar study conducted in the state of Texas analyzed the reading grade level of 3rd to 11th grade mathematics assessment items on the state mandated Texas Assessment of Knowledge and Skills (TAKS) (Lamb, 2010). The readability level was calculated through an electronic database similar to the method used by Acosta-Tello (2010). Lamb posited that a readability level above a student’s grade level would hinder mathematical performance. His research findings indicated general education students performed significantly better when test questions were at, or below, their grade level in reading comprehension, and performed significantly lower if test questions were above their current grade level. Lamb’s study did not address students with disabilities; though,
it supported the dualistic nature between mathematical word problems and reading comprehension.

In order to obtain a more accurate representation of the achievement level of a seventh grade student with LD in mathematical problem solving, the reading difficulty of assessment and textbook items need be considered. Schools should not be penalized twice for reading performance, in language arts and mathematics, on state standardized tests (Lamb, 2010). Mathematical problem solving should be strictly designed to measure mathematical performance at a level the student can comprehend. Acosta-Tello (2010) stated:

Finding the solution to a word problem should not task the reading skills of the student. The task of solving a word problem should mean that students are asked to apply math computational skills with which they demonstrate a degree of mastery to solve a word problem that is decodable, decipherable, and whose meaning is readily accessible to the reader. (p. 24)

Acosta-Tello provided suggestions for instructional strategies to support student achievement in solving math word problems, such as reading the narrative passages aloud, rewriting the problems in a simpler language, or collaborative grouping to assist with the analysis of word problem narratives. These instructional strategies can guide students through the process of deciphering complex, lengthy narrative mathematical word problems (Acosta-Tello).

In addition, reading difficulty with word problem solving task(s) can be attributed to factors such as mathematical content and structure (Xin, 2007). Xin conducted a study of 57 middle school students with LD to examine student success rate with computing
math word problem tasks within U.S. textbooks. Student responses were used as data to measure the outcome of the study (Xin). The study revealed U.S. students perform higher on word problems which displayed a consistency in language, versus problems that varied in language structure (Xin). Xin recommended students be given opportunities to solve similar content problems with a differentiation on surface appearance. This would broaden students’ conceptual understanding because they would be challenged to repeatedly identify the unknown variable (Xin). Xin adds to the literature by providing practical implications for future teaching methodologies to provide diversity in problem structure when solving similar content problems.

Another study implemented by Powell, L. Fuchs, D. Fuchs, Cirino, and Fletcher (2009) examined word-problem features and their effects on students with math difficulties (MD) versus students who have both reading difficulties (RD) and MD (MDRD). Powell et al.’s study consisted of 109 MD students and 109 MDRD students. The purpose of the study was to investigate if students with MD differ in their performance when compared to students with MDRD.

One hundred thirty-four third grade classrooms participated in the 14-item word problems test, which included identifying missing information and 3 different problem types: difference, change, and total (Powell et al., 2009). Through data analysis of the 14-item Word Problem test, Powell et al. confirmed their hypothesis that students with MD perform higher than students with MDRD due to the high demand of language and reading required for computing mathematical word problems. The findings suggest that students with MDRD have deficiencies in computing math word problems with high language and reading requirements. The study further identified that problem types pose
different challenges for MD and MDRD students. These findings further suggest students with MD and MDRD may benefit from differentiated instruction (Dirks, Spyer, van Lieshout, & Sonneville, 2008; Powell et al.).

The literature suggests mathematical word problems and reading comprehension are interrelated in regards to student achievement (Vilenius-Tuohimma, Aunola, & Nurmi, 2008). In order for students to become proficient in solving math word problems, students must become proficient in reading comprehension (Vilenius-Tuohimma et al.). It is important to note students with combined reading and math difficulties have shown to be less successful in solving mathematical word problems when compared to students with a single-deficit in math or reading exclusively (Dirks et al., 2008). When determining the appropriate instructional strategies for students with LD, it is essential that researchers and educators determine which instructional tools and methods are efficient in supporting academic achievement with solving mathematical word problems.

**Teaching Students with LD to Solve Math Word Problems**

When reviewing the literature on teaching students with LD to solve mathematical word problems, one instructional approach emerged frequently. Schema-Based Instruction (SBI) is a framework to assist students with solving math word problems (Powell, 2011). Powell described SBI as an instructional tool to teach students how to recognize, as well as how to organize, a problem’s information.

Each empirical study reviewed in Table 1 addresses SBI and its effect on the mathematical performance of students with LD within a typical classroom setting. The study included 1,075 students with challenges in mathematics. Of these students, 414 were at-risk for being identified as having LD, 195 were students with learning problems,
60 were identified as students with LD in the area of arithmetic, 405 were classified as students with LD, and 1 student was labeled as a child with emotional disturbance. The researchers in the following studies sought to identify if semantic strategy instruction, as well as schematic problem types, had a positive effect on solving math word problems.

Table 1

*Description of Schema Studies*

<table>
<thead>
<tr>
<th>Authors</th>
<th>Study design</th>
<th>SBI instruction</th>
<th>Grade</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garcia, Jimenez, &amp; Hess</td>
<td>Tested word problem difficulty by examining: schematic structure, operation, and position of an unknown quantity</td>
<td>Schematic word problems were incorporated and analyzed to determine word problem difficulty</td>
<td>7 years and 1 month to 9 years and 4 months</td>
<td>The study aimed to identify the difficulty of three problem types. The results showed that schematic structure alone was not enough to determine the level of difficulty.</td>
</tr>
<tr>
<td>Van Garderen (2007)</td>
<td>Intervention was divided into three parts: explicit instruction, guided and independent practice, and reinforcement</td>
<td>Students were taught how to generate a schematic diagram</td>
<td>Eighth</td>
<td>The use of schematic diagram was related to higher levels of student performance than pictorial diagrams.</td>
</tr>
</tbody>
</table>
| Maccini, Mulcahy, & Wilson (2007) | Synthesis of literature to determine current math interventions including SBI to assist students with LD | -Explicit SBI to help students understand the structure of math word problem  
-One study investigated the effects of SBI versus general strategy instruction (GSI) | Middle school                | -Increased students’ performance  
-SBI students had more significant gains from pre to posttest results a GSI student                        |
| Powell (2011)            | Synthesis of literature on schemas within word-problem instruction          | Explicit instruction on solving word problems through schematic instruction     | Second and third            | Students at-risk for or with LD benefit from instruction that incorporated schemas.                   |
The studies in the current review, Table 1, indicate positive correlations between SBI and mathematics word problem solving. However, two of the studies included implications, which may affect the reliability of the findings. Van Gardener’s (2007) study consisted of only three participants. This small number of participants limits the amount of data collected and reliability of the study. The second research study, Powell (2011), analyzed empirical research across several different instructional settings: whole class instruction, small groups, and tutoring sessions. She posited that the small group instruction and tutoring sessions added value to the outcome of the study due to the benefits of individualized attention, versus studies which implement SBI within a whole class setting. Table 1 also included two research studies which incorporated a series of instructional strategies, including SBI, to enhance student progress with solving math word problems (Van Garderen; Maccini et al., 2007). These two studies suggest SBI is one of many methodologies which can aid in the improvement of mathematical word problem performance for students with LD.

Xin and Zhang (2009) explored a Conceptual Model-Based Problem Solving (COMPS) approach to teach situated word problems, which they noted as a more efficient method than SBI because the problem solver was not required to determine the mathematical operation. They also noted students with disabilities experienced difficulties with SBI due to the need to identify keywords in order to determine the correct mathematical operation. The task of identifying keywords assumes the problem solver is an able reader who can read and comprehend the text. This connects to the previous section in the literature, which suggests students with LD struggle with solving math word problems that require a high degree of reading comprehension (Lamb, 2010).
Xin and Zhang’s (2009) COMPS strategy is a conceptual model, in the form of an equation, used to solve word problems for an unknown quantity. The participants included in this study were fourth and fifth grade students with, or at risk for, mathematics disabilities. The study began with an intervention phase where students received two one-hour training sessions on effectively using a pre-developed task oriented list. Xin and Zhang called this checklist “DOTS” (p. 432), which stood for “detect, organize, transform, and solve” (p. 432). The DOTS checklist was designed to assist students through the COMPS strategy approach. The study revealed the COMPS approach could improve student problem solving skills when computing mathematical word problems (Xin & Zhang).

Embedded within Xin and Zhang’s (2009) study was the use of the sentence mnemonic device, DOTS, to assist students with remembering the necessary steps for carrying out the COMPS strategy approach. Empirical articles have incorporated similar mnemonic strategies which have proven to be useful tools to aid with self-monitoring and improving academic performance among students with LD at the secondary and postsecondary levels (Maccini et al., 2007; Strickland & Maccini, 2010). A common acronym used in math is STAR, which cues students to complete problem solving steps (Maccini et al.; Strickland & Maccini). The acronym STAR consists of the following sentence mnemonics: “Search the word problem, Translate the problem, Answer the problem, Review the solution” (Maccini et al., p. 66). Maccini et al. indicate proper implementation of STAR requires instructional practices, such as teacher modeling, guided and independent practice, and corrective feedback. The results yield promising
interventions, which can be adapted to fit future studies in mathematical problem solving for students with LD (Maccini et al.).

A similar study developed by Chung and Tam (2005) used a comparable task-oriented list. They investigated the effects of three instructional approaches on mathematical problem solving by learners with mild intellectual disabilities, which is referred to in Hong Kong as an IQ between 55-70, as measured on the Wechsler Intelligence Scale for Children III. Chung and Tam further examined the use of three different teaching strategies: conventional, worked examples, and cognitive strategy instruction.

The three test groups were given the same instruction on mathematical terms for the first session (Chung & Tam, 2005). The proceeding four sessions categorized students into either the conventional, worked examples, and cognitive instruction group. Students in the conventional group were given direct instruction with solving math problems on the board, and were then given a few minutes to solve problems independently. The worked example group was taught to visualize the problem through diagrams and pictorial images. The examiner read the questions aloud and showed the steps to solve each problem. The cognitive strategy group was taught how to use a meta-cognitive process to monitor their own thinking and learning. Students were encouraged to follow a pre-designed task oriented list which asked students to “read the problem, select the important information, draw a representation of the problem, write down the steps for doing the computation, check the answer” (Chung & Tam, p. 211). The cognitive strategy group and the worked example group out-performed students in the conventional group on the post-test assessment. Chung and Tam’s findings add to the body of
literature by proposing the need to facilitate higher order conceptual thinking among students with LD. These findings also support the positive effects of using a pre-generated task oriented list to guide students toward becoming independent problem solvers (Chung & Tam).

The above methodologies have assisted students with disabilities in performing mathematical operations that require conceptual understanding, vocabulary comprehension, and independent problem solving. The results of each instructional strategy have shown positive gains in student achievement with solving mathematical word problems. Some discrepancies exist within the research in regards to its reliability and effects among a population of students with LD (Powell, 2011; Van Gardener, 2007; Xin & Zhang, 2009). The research findings add to the body of literature to assist with the development and implementation of mathematics instruction within the classroom.

**Teaching Methodologies to Assist with Vocabulary Instruction**

Without a thorough understanding of mathematics vocabulary, students cannot maximize achievement on state assessments as mandated by NCLB (2001) (Downing, Earles-Vollrath, Lee, & Herner-Patnode, 2007). Vocabulary knowledge is linked to reading comprehension, which is necessary to solve complex math word problems (Downing et al.,). Teaching mathematics vocabulary should be embedded within the curriculum in order to support students in meeting the language demands within high-stakes testing (Pierce & Fontaine, 2009). Since the establishment of NCLB, annual testing of all students in grades 3 through 8 requires states reach proficiency in language arts and mathematics within 12 years (Downing et al.). These statewide progress
objectives require educators to draw upon current teaching methodologies which can impart word knowledge in mathematics upon students (Downing et al.).

Sedita’s (2005) review of literature provides several instructional strategies which address effective vocabulary instruction within the classroom, such as in class oral reading activities through teacher-read-aloud text or independent reading assignments. This indirect instructional strategy can be supported regularly within the classroom if students are exposed to different reading context throughout the instructional period. Direct vocabulary instruction can be taught through explicit vocabulary instruction on key words, which are pre-selected to support student comprehension on an upcoming lesson (Sedita). Sedita included several key methods for selecting appropriate, content specific, vocabulary words, such as identifying unfamiliar words students may find challenging, frequently appearing words within text, or words which assist students with building prior knowledge. Direct vocabulary instruction should give students the opportunity to actively engage in discussions and activities where students can apply and use the pre-selected key vocabulary words (Sedita).

McKeown and Beck’s (2004) research study reviewed many of Sedita’s (2005) findings, which address effective vocabulary instruction within the classroom. When selecting key vocabulary words, McKeown and Beck provided two strategies to pre-determine content appropriate words. The first approach was analyzing the pre-selected word’s definition. If the definition consisted of unknown or challenging words, then the word was considered inappropriate for the student. The second component was selecting words that were interesting or meaningful to the student (McKeown & Beck). McKeown and Beck’s study also indicated the importance of active engagement and the opportunity
to apply key vocabulary in a variety of situations. Informal versus formal instructional strategies were addressed, which similarly relate to the aforementioned indirect and direct teaching strategies. Direct and formal strategies consist of teacher lead explicit instruction, whereas indirect and informal strategies refer to exposure to content rich academic language or text (McKeown & Beck; Sedita).

Other instructional strategies include the use of context clues. Students are taught to use the surrounding text to determine a word's meaning (McKeown & Beck, 2004; Sedita, 2005). This method, however, is not always reliable, due to inconsistencies in contexts (McKeown & Beck; Sedita). McKeown and Beck developed four classifications to describe the different context structures: directive, general, nondirective, and misdirective. The former two classifications provide enough information within the structure of the sentence to determine the meaning of a word, and the latter two either provided minimal assistance, or direct the reader toward developing an incorrect definition (McKeown & Beck). McKeown and Beck stress the importance of teaching students this instructional approach with the general understanding that not all sentences can correctly identify the meaning of an unknown word. Downing et al. (2007) support this notion by stating “Developing adequate vocabulary in mathematics is crucial because few contextual clues in mathematical text help decode the meaning of the mathematical vocabulary” (p. 122).

Sedita’s (2005) and McKeown and Beck’s (2004) research findings analyze specific vocabulary instruction that was designed for teaching reading comprehension within a language arts setting. Neither study discussed whether or not these instructional strategies were effective procedures that could be conducted across academic settings,
such as a mathematics classroom. McKeown and Beck did not include students with LD in their study, and Sedita vaguely defined the challenges students with LD encounter with reading as a result of poor phonemic awareness and phonics skills. The following two studies were incorporated to provide an understanding of effective vocabulary instruction.

Downing et al. (2007) outlined five components by the NCTM which describe the following mathematical processes: “problem solving, reasoning and proof, communication, connections, and representation” (p. 122). These instructional strategies should be implemented as a whole and should be integrated within mathematics lessons (Downing et al.). Table 2 illustrates the five instructional components used by a fourth-grade teacher in the study, Deb, to teach mathematics vocabulary to a diverse group of students. The participants in the study included students in an accelerated math class and three regular mathematics classes which included students with varied learning needs (Downing et al.).

Table 2

*Deb’s process standards strategies implemented within the classroom*

<table>
<thead>
<tr>
<th>Process standard</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Solving</td>
<td>Students analyzed math vocabulary words and presented their findings within a small group setting. The group would work together to create a final definition for the unknown math word.</td>
</tr>
<tr>
<td>Reasoning and proof</td>
<td>Students used vocabulary notebooks to aid in comprehension. They incorporated definitions and visual images to help them construct meaning for a new mathematical term.</td>
</tr>
<tr>
<td>Communication</td>
<td>Communications assisted students with opportunities to learn and practice new math vocabulary words. Students communicated with the teacher, peers, and within their vocabulary notebooks.</td>
</tr>
<tr>
<td>Connections</td>
<td>Word cards with the mathematical term and definition were created by the student and placed on a designated section of the whiteboard.</td>
</tr>
<tr>
<td>Representation</td>
<td>Modeling, flashcards, kinesthetic approaches, and motion-involved activities gave students the opportunity to represent the meaning of a word in a fun and notable approach.</td>
</tr>
</tbody>
</table>
Downing et al. (2007) presented several vocabulary methodologies which addressed a wide-range of teaching modalities, such as kinesthetic, visual, auditory, and tactile for assisting students with disabilities. Educators of students with and without LD should incorporate several learning modalities within a lesson (Downing et al.). Exposure to a combination of the different learning methods will assist students of varied learning abilities with comprehension and retention (Downing et al.). Deb used the same instructional strategies in all of her mathematics classes; however, she made instructional changes in her pacing plan and presentation of the instructional material based on her students’ individualized needs (Downing et al.). Downing et al. ‘s research study provided concrete teaching strategies to build mathematics vocabulary among students with diverse learning needs; however, they did not mention the identified LD of the population of students within their study.

In response to the current research, which indicates the critical role of vocabulary knowledge and its direct correlation with reading comprehension, Pierce and Fontaine (2009) conducted a study which analyzed the vocabulary demands of the Massachusetts Comprehensive Assessment System (MCAS) math test. Pierce and Fontaine analyzed third grade words on the MCAS, and then categorized the vocabulary terms into two sections, “technical and subtechnical words” (p. 240). According to Pierce and Fontaine, technical vocabulary words are more likely to be incorporated within mathematics instruction and are a necessity for the students to solve word problems. Words such as addition, estimate, and subtract are examples of technical vocabulary words which must be taught explicitly in order for students to comprehend and compute a math word problem (Pierce & Fontaine). Subtechnical vocabulary should also be taught explicitly,
though these words tend to be overlooked due to their ambiguous nature. Subtechnical vocabulary words are multiple meaning words such as *ruler*, *table*, and *belongs* (Pierce & Fontaine). These words impose challenges for students and should be taught in conjunction with technical vocabulary words in order to increase student understanding with solving mathematical word problems (Pierce & Fontaine).

The above studies add to the literature by providing instructional strategies for implementing mathematics vocabulary within a classroom setting. They share a commonality among the research by indicating the importance of increasing vocabulary knowledge in order to aid with comprehension. The literature is limited to empirical studies, which include vocabulary instruction in a mathematics setting for students with LD. Downing et al.’s study incorporated all three aforementioned characteristics, but the study lacked specific information in regards to the disabilities of the students. The remaining literature presented within this subheading included studies which focused exclusively on either one or two of the following components: vocabulary and comprehension, mathematics and vocabulary, or vocabulary and LD. This thesis study intends to fill the gap regarding the limited amount of research in solving mathematical word problems accompanied with vocabulary instruction among students with LD.

**Self-Regulation: An Aide for Vocabulary Development**

If students with LD can identify the challenges they face when solving math word problems, they will be one step closer to gaining a solution. Students with LD should be given tools to monitor their thinking processes when solving complex and lengthy narrative math word problems. Cognitive engagement can be achieved through self-
regulatory strategies that can assist in self-awareness, monitoring levels of difficulty, and motivation (Boekaerts & Corno, 2005).

Several research studies have outlined the positive correlation between mathematical achievement and self-regulatory strategies (Montague, 2007, 2008; Perels et al., 2009). Teaching students how to take control over their own learning has emerged in education as an instructional tool to teach students to become active learners (Perels et al.). Montague (2007) states, “Self-regulation is a metacognitive function essential to academic success. Students with LD are notoriously poor at self-regulation and must be taught explicitly to monitor and control their cognitive activities as they engage in academic tasks such as mathematical problem solving” (p. 75). Montague (2008) examined seven studies that incorporated self-regulation strategies as an instructional approach for mathematical problem solving. She was able to recognize the cognitive demands embedded in each study and identify a correlation in enhanced mathematical performance. Montague (2008) concluded the study with providing eight principles of strategy instruction, which she deemed as the basis for appropriate implementation and should be used as guidelines for self-regulation strategies in future research.

According to Montague (as cited in Cassel & Reid, 1996), principle one addresses the role the educator has with deciding the following factors: content, instructional strategies, and procedures. She indicated the preceding key issues need to be examined and carefully planned out before self-regulation strategies can be effectively implemented. Principle two states there must be some form of academic measure to identify if students are achieving understanding (Montague, 2008), such as a pre and post math assessment, informal observation, or a teacher-generated checklist. In the third
principle, Montague (2008) indicates a component of instruction in one area will not result in the same outcome in another area (as cited in Swanson, 2000). This may be due to the incorporation of human subjects and the inability to assume that because one component of instruction works for a particular group, it will work for another. This leads into principle four, which states, “Comparable performance does not mean students use comparable processes or strategies” (Montague, 2008, p. 43), meaning on any given math test, all students may receive the same passing score, though the instructional strategies or procedures the students used during the test may vary.

Principle five is proper consideration of a student’s knowledge (Montague, 2008). Montague (2008) indicated it is essential for teachers to pre-determine the mathematical abilities of their students prior to the administration of a self-regulatory activity. An example would include a teacher who should not teach solving percentage word problems through the use of self-regulation strategies if his/her students are not capable of multiplying or dividing by decimals. The outcome of the study would then suggest self-regulation strategies are ineffective for their population of students when the results may have been largely influenced by their students’ inability to compute basic arithmetic with decimals. The next principle describes how students with LD may be able to carry out self-regulation strategies effectively, but still struggle with reaching grade-level performance (Montague, 2008). In this scenario, additional accommodations may be necessary in order to foster student achievement (Montague, 2008). Principle seven emphasizes not all self-regulation strategies are applicable across settings (Montague, 2008). A general-education math class showing significant gains in higher-order
cognition when using a self-regulatory checklist may not equate to the same outcome if used on a student population with LD (Montague, 2008).

Lastly, Montague (2008) states self-regulation strategies cannot be generalized across content areas (as cited in Pressley, Brown, El-Dinary, & Allferbach, 1995). It is the responsibility of the teacher to help transfer self-regulatory strategies across academic settings, or to clarify that the instructional strategies may not be transferable to other academic areas (Montague, 2008). Montague’s (2008) eight principles are general guidelines which should be understood if educators are to appropriately implement self-regulatory strategies within their classrooms.

Perels et al. (2009) evaluated the effectiveness of self-regulatory strategies to improve mathematical achievement among sixth grade students. The study consisted of 53 students who participated in a pre-test/post-test control group design model conducted over a 3 period. The experimental group was taught self-regulated learning strategies that emphasized “positive attitude toward mathematics and learning, motivation, goal-setting, planning, and dealing with distractions” (Perels et al., p. 22). The above self-regulative strategies were accompanied with the same mathematical content presented to the control group. The results yielded a favorable improvement of mathematic performance amongst the experimental group.

Perels et al.’s study shows it is possible to support mathematical achievement through self-regulatory strategies within a regular sixth grade classroom. However, their study did not specify if the mathematical problems were strictly computation or math word problems, which can either eliminate or enhance the added challenges of reading comprehension and vocabulary knowledge of mathematical operations. In addition,
Perels et al.’s study did not address students with LDs and was limited to one teacher throughout the study.

A second study by Montague (2007) provides several examples of intervention research at the elementary, middle, and secondary level for students with LD in mathematics. The studies offer several self-regulatory methods that have been implemented effectively within a classroom setting. Two of the most commonly used strategies were self-monitoring of attention and self-monitoring for performance (Montague, 2007).

Performance self-monitoring techniques measured productivity, accuracy, and strategy, such as monitoring the number of math problems completed, number of correctly solved problems, and if the necessary steps were taken to complete the given problem (Montague, 2007). Montague (2007) incorporated one study which used an individualized self-monitoring statement list to assist a student with solving subtraction problems that required borrowing. The statement list consisted of the following “1. I copied the problem correctly. 2. I regrouped when I needed to (top number is bigger than the bottom). 3. I borrowed correctly (number crossed out is one bigger). 4. I subtracted all the numbers. 5. I subtracted correctly” (Montague, 2007, p. 76). The implementation of a self-monitoring system increased student accuracy in response to math problems.

Attention self-monitoring techniques are designed to teach students to assess whether or not they are attending to the academic task (Montague, 2007). Montague (2007) describes one study in which three students with MLD were given self-instruction lessons that were recorded by the students, and then later used to assist them with solving math problems independently (as cited in Wood, Rosenberg, & Curran, 1993). Students
who participated in the aforementioned study improved in their abilities to solve math problems with greater accuracy (Montague, 2007).

The purpose of self-regulatory strategies is to teach students the necessary skills they need to become independent problem solvers (Montague, 2007). Through self-questioning, students can begin to ask critical questions that will support the academic demands they face with solving mathematical word problems. Examples of these critical questions include: “Do I understand the problem?” or “What does this particular word mean?” These questions may assist students with LD in solving lengthy narrative word problems that have a high degree of vocabulary content. Students who are faced with vocabulary demands will be expected to address these fundamental questions on their self-regulation checklist, which has been shown to increase student productivity and attention with mathematical problem solving (Montague, 2007).

Real-Life Connections

Educators continue to make efforts to reform the mathematics curriculum to assist students with LD with meeting the increasing demands of mathematical word problems (Anzelmo-Skelton, 2006). One instructional approach that has emerged in education is the use of real-life connections (RLC) between mathematical problem solving and its integration of daily living skills within an academic setting (Patton, Cronin, Bassett, & Koppel, 1997). McNair (2000) indicated that in order to enhance student achievement, there needs to be a connection between the students’ life outside the classroom and the material being presented in class. He also suggested instructional methods within the classroom should shift from the formal model of rote memorization of facts and teacher directed instruction, to a student-lead participation model that encourages active student
engagement. “Both of these reform efforts will change the students’ role in the classroom, from that of a knowledge consumer to a knowledge producer” (McNair, p. 551).

McNair (2000) furthers his study by discussing how different social environments may systematically change the role of classroom activities. Teachers should develop lessons that will give their population of students an opportunity to develop thought-provoking questions. According to McNair (2000), if the lesson is relevant to the student, then there is more likely to be an increase in participation, which can lead to improved comprehension and performance with mathematical problem solving. McNair’s overall findings suggest teachers must consciously recognize the learning desires of their students in order to make meaningful connections between mathematical concepts and their students’ lives outside the classroom.

Downing et al. (2007) incorporated the use of RLC within a math vocabulary lesson. The teacher brought in objects, such as a cereal box, to teach students about rectangular prisms. She continued her lesson by having the students visualize items at home that fit the criteria of a solid three dimensional, six-faced figure. Downing et al. suggested the incorporation of concrete objects within a mathematics lesson could help students make connections to prior experiences.

Patton et al. (1997) also recognized the importance of developing meaningful mathematics instruction to prepare students with LD with the challenges they may encounter in the work place. Programs should be created in high school, which teach students about personal financing, such as money management and savings (Patton et al.). Patton et al. also suggested incorporating a basic math skills class to enhance a
student’s problem solving skills to assist with general daily functioning within his or her community. Programs such as these will give students with LD the opportunity to make RLC within the classroom to prepare them for adulthood (Patton et al.).

To assist students with LD, it is pivotal that educators are exposed to current research-based practices, such as RLC and self-regulation, to increase student performance in solving mathematical word problems. RLC should be embedded within mathematics lesson to capitalize on students’ interest, which will foster student engagement and academic growth (Patton et al., 1997). Self-regulatory strategies can accompany RLC in order to increase productivity and accuracy with solving mathematical word problems. In addition, it is essential educators consider their students’ language capabilities in regards to vocabulary knowledge and reading comprehension, and provide students with strategies to face the language demands embedded in mathematical word problems (Lamb, 2010). The incorporation of a self-regulatory checklist can be a practical tool to monitor comprehension and advance student achievement for students with LD. Quality instruction should determine the structural sequence in which mathematics should be taught, how it should be taught, and how it should be assessed (Downing et al., 2007).

**Framework**

For the purpose of this thesis, a single analytical platform will serve as the foundation for this qualitative research study. The proposed model is based on standards mandated by the federal government in 1989, which were designed to guide educational practitioners responsible for teaching primary aged students (Hamilton et al., 2007).
These standards later became the guiding policy behind the NCLB, which required states to adopt and apply content standards in all core academic areas (McCombs, 2005).

California’s plan to implement NCLB was established through the California Department of Education (CDE) (California State Board of Education, 1997) curricular framework (CDE). The curriculum framework, also known as content standards, outlines what students in California public schools should be able to do at each grade level. The implementations of the content standards within the classroom are based on the district, school, or teacher’s discretion (CDE). The California Mathematics Content Standards (CMCS) guided the researcher through evaluating procedures within this qualitative research study.

The seventh grade CMCS will be the foundation for this thesis study. According to the CDE (1997), students in the seventh grade should be able to solve percentage problems, which include a percent increase and decrease. Standard 1.7 requires all students “solve problems that involve discounts, markups, commissions, and profit and compute simple and compound interest” (California State Board of Education, p. 30). The evaluative framework is designed to determine this study’s effectiveness, relevance, and efficiency.

**Summary**

In order for students with LD to meet the large demands of high stakes testing, they must be taught effective practices, steeped in research, which can enhance their performance with solving mathematical word problems. The review of literature provides an assortment of teaching methodologies to assist with mathematical problem solving and vocabulary development. The development of vocabulary knowledge is
essential in order to assist students with LD in comprehension, which is a necessity when solving math word problems. Students with LD need frequent support with monitoring their performance and attention when solving mathematical word problems. Strategies, such as self-regulation and RLC, should be included in teaching practices to assist students with LD in meeting the difficulties they face when solving mathematical word problems.
CHAPTER 3: Methodology

Word problems in mathematics have posed numerous challenges for students with learning disabilities (LD), due to complex cognitive activity and the number of processes required to arrive at a solution. During the last two decades, there has been a shift in student curriculum and teacher accountability in order to assist students with LD in meeting demands of high stakes standardized assessments under No Child Left Behind (NCLB). Higher expectations in mathematics instruction and effective research based practices need to be implemented within the classroom in order to remedy performance gaps in math word-problem proficiencies.

The intent of this thesis is to identify best practices for assisting seventh students with LD in solving math word problems. On this basis, the researcher will address the following two research questions:

- Can vocabulary instruction combined with self-regulation strategies assist seventh grade students with LD in developing problem solving skills to solve percentage word problems?

- Can real life connections (RLC) assist seventh grade students with LD in obtaining a deeper understanding of percentage word problems?

It is beneficial to identify instructional strategies and activities involved in providing students with LD an opportunity to access the curriculum through research based practices. In this effort, a qualitative study using an experimental design will be applied.
About the Case

Thirteen students with specific learning disabilities (SLD) participated in this thesis study. Initial criterion for participation for the study were as follows: (a) met district eligibility as a student with a SLD, (b) currently enrolled in the researcher’s seventh grade special day program mathematics classroom, and (c) scored below proficient on the California Standardized Test (CST) or California Modified Assessment (CMA) in mathematics. The California Department of Education (CDE) defines proficiency as the ability to demonstrate mastery of grade level standards on the CST or CMA.

Due to the range of disabilities found within a special day program, five students did not meet the eligibility requirements based on their disabilities as identified in their Individualized Education Program (IEP). Three students were classified as autistic, one student with visual impairment, and one student as hard of hearing. These students were incorporated within the study in order to provide equal access to the content-based curriculum mandated under No Child Left Behind Act (NCLB) of 2001. However, the results and findings of these five students will not be included within the research findings. The name of the school and participants were altered for confidentiality.

The participants in the study were diverse in ethnicity and social economic status, due to the school’s open-boundary policy regarding school choice, and its location in an urban community. The school site used for the study received Title I funding based on the high percentage of children from low-income families. Eighty-nine percent of the student population at Mann-Krieger Middle School (MKMS) qualified for a free or reduced priced meal plan. Eligibility requirements were based on household income
criteria under district guidelines. The ethnic make-up of the students in attendance at MKMS consist of the following: 90.2% Hispanic, 4.6% White, 3.3% African American, .7% Asian, 1.1% Filipino, and .2% America Indian. The demographic characteristics of the 13 participating students within the study are indicated in Table 3.

Table 3

Demographic Characteristics of Participating Students

<table>
<thead>
<tr>
<th>Students</th>
<th>Ethnicity</th>
<th>Age</th>
<th>Gender</th>
<th>Math Exam Performance</th>
<th>Free or Reduced Lunch</th>
<th>Years in Special Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lola</td>
<td>Hispanic</td>
<td>12-4</td>
<td>Female</td>
<td>CMA- Far Below Basic</td>
<td>Yes</td>
<td>8</td>
</tr>
<tr>
<td>Ariel</td>
<td>Hispanic</td>
<td>12-3</td>
<td>Female</td>
<td>CMA-Below Basic</td>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>Meyer</td>
<td>Hispanics</td>
<td>12-7</td>
<td>Male</td>
<td>CST-Below Basic</td>
<td>Yes</td>
<td>8</td>
</tr>
<tr>
<td>Darrel</td>
<td>Black</td>
<td>13</td>
<td>Male</td>
<td>CST- Far Below Basic</td>
<td>Yes</td>
<td>5</td>
</tr>
<tr>
<td>Caroline</td>
<td>Black</td>
<td>12-8</td>
<td>Female</td>
<td>CMA-Below Basic</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>Lucia</td>
<td>Hispanic</td>
<td>13-6</td>
<td>Male</td>
<td>CMA-Below Basic</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>Mickey</td>
<td>Hispanic</td>
<td>13</td>
<td>Male</td>
<td>CST-Below Basic</td>
<td>Yes</td>
<td>6</td>
</tr>
<tr>
<td>Marco</td>
<td>Hispanic</td>
<td>14</td>
<td>Male</td>
<td>CMA-Basic</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>Brice</td>
<td>Black</td>
<td>13-6</td>
<td>Male</td>
<td>CMA-Below Basic</td>
<td>Yes</td>
<td>3</td>
</tr>
<tr>
<td>Michael</td>
<td>Hispanic</td>
<td>14</td>
<td>Male</td>
<td>CST-Below Basic</td>
<td>Yes</td>
<td>3</td>
</tr>
<tr>
<td>Melissa</td>
<td>Hispanic</td>
<td>12-10</td>
<td>Female</td>
<td>CMA-Basic</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>Jason</td>
<td>Black</td>
<td>12-3</td>
<td>Male</td>
<td>CMA-Below Basic</td>
<td>Yes</td>
<td>5</td>
</tr>
<tr>
<td>Patty</td>
<td>White</td>
<td>13-1</td>
<td>Female</td>
<td>CST-Below Basic</td>
<td>Yes</td>
<td>2</td>
</tr>
</tbody>
</table>
The CDE enforces the use of a curriculum framework or content standards, which are taught at each grade level. The researcher used a portion of content standard 1.7 as the basis for the study. Participants in the study solved percentage word problems, which focused on discounts, commission, and profit. The California Mathematics Content Standard (CMCS) was the criteria for this study and was used to determine the study’s effectiveness.

**Research Design**

This thesis study used an experimental design method to collect qualitative data in order to determine if vocabulary instruction, combined with self-regulation, can assist seventh grade students with LD in developing problem-solving skills to answer percentage word problems. The 13 participants within this study were assigned to a treatment and control group based on the school district’s special education eligibility criteria for students with SLD. The district’s manual indicates that a student must display “a severe discrepancy between achievement and intellectual ability in one or more of the following areas: oral expression, listening comprehension, written expression, basic reading skill, reading fluency skill, reading comprehension, mathematics calculation, and mathematics reasoning” \(^1\) (MKMS District Manual, 2007, p. 39). If a discrepancy is present, then a “disorder must exist in one or more of the basic psychological processes: attention, auditory processing, visual processing, sensory motor skill, and cognitive abilities including: association, conceptualization, and expression” \(^2\) (MKMS District Manual, 2007, p. 39).

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\(^1\) The name of the school’s district manual has been altered to comport with confidentiality considerations required by CSUN’s Institutional Review Board

\(^2\) The name of the school’s district manual has been altered to comport with confidentiality considerations required by CSUN’s Institutional Review Board
Manual, 2007, pp. 39-40). Participants within this study were separated into two groups based on the aforementioned disorders.

According to McEwan and McEwan (2003), the purpose of a control group is to “approximate what the treatment group would have looked like in the absence of the treatment” (p. 38). They further emphasize the two groups must be similar at the beginning of the study in order to identify any differences in the outcome of the study. For this study, the participants were similarly based on the initial criteria. They were separated into a control and treatment group based on the five psychological processes, as defined by a specific learning disability. A summary of the students’ characteristics is presented in Table 4.

Table 4

*Learning Disability and the Five Psychological Processes*

<table>
<thead>
<tr>
<th>Students</th>
<th>Attention</th>
<th>Visual Processing</th>
<th>Auditory Processing</th>
<th>Sensory Motor Skills</th>
<th>Cognitive abilities including association, conceptualization &amp; expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lola</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ariel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meyer</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Darrel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caroline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lucio</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mickey</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marco</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brice</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michael</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melissa</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jason</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patty</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Participants within the study were separated based on the five psychological processes as indicated on their Individualized Education Program (IEP). The researcher tried to evenly disperse participants into a control group, or treatment group, based solely on the above criteria. The names of the participants were voided in advance to prevent personal perspective or subjectivity within the research design. The researcher used this randomized method due to the nature of the study: assisting students with LD in solving percentage word problems through a self-regulatory method.

Table 5 reveals the experimental design groups and their five categorizations under a specific learning disability. The treatment group consists of seven participants and the control group includes six. The researcher was unable to create a control group and treatment group with an even number of psychological processes due to the uneven number of subjects, as well as their varied number of psychological classifications.

Table 5

Treatment and Control Group

<table>
<thead>
<tr>
<th>Control Group</th>
<th>Participants may have one or more of the following psychological processes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Auditory Processing 5</td>
</tr>
<tr>
<td></td>
<td>Visual Processing 2</td>
</tr>
<tr>
<td></td>
<td>Attention 2</td>
</tr>
<tr>
<td></td>
<td>Sensory Motor Skills 2</td>
</tr>
<tr>
<td></td>
<td>Cognitive abilities including association, conceptualization &amp; expression 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>Participants may have one or more of the following psychological processes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Auditory Processing 6</td>
</tr>
<tr>
<td></td>
<td>Visual Processing 3</td>
</tr>
<tr>
<td></td>
<td>Attention 2</td>
</tr>
<tr>
<td></td>
<td>Sensory Motor Skills 3</td>
</tr>
<tr>
<td></td>
<td>Cognitive abilities including association, conceptualization &amp; expression 1</td>
</tr>
</tbody>
</table>
A qualitative research design was used to identify a remedy to assist with addressing the performance gap in solving mathematical word problems. Clark and Estes (2008) posit, “The type of support people need can only be determined after an analysis of what is required to close a specific gap and whether this required elements are readily available in the organization” (p. 42). This thesis study sought to identify effective instructional methods to bridge the gap between goals and student performance. The researcher generated qualitative findings through observation of student activities, behaviors, and interpersonal interactions (Patton, 2002). Data was collected and examined for themes and patterns to construct credible qualitative findings.

**Why a Case Study**

A case study is a form of qualitative descriptive research that is used to focus on human behavior (McEwan & McEwan, 2003). The researcher used a case study design with a small group of participants for direct observations and data collection. The 13 participants at MKMS were used to identify how and why students with LD face challenges with solving percentage word problems. The case study allowed the researcher to focus on particular habits and recurring themes found within student behavior.

**Framework for this Case Study**

The framework selected for this observation began with the federal education legislation of NCLB and Individuals with Disabilities Education Improvement Act (IDEIA). Both laws were mandated to improve the educational performance of special education students. California’s plan to address these federal mandates was established through the CDE curricular framework (CDE). By utilizing the CMCS, this case study
enables other researchers to evaluate instructional procedures and methods, which could assist students with LD in meeting the required grade level standards.

**Teaching Method and Materials**

Participants were broken into two groups, treatment and control. They were separated based on their psychological processes as determined under their eligibility as a student with SLD. The study took place over a course of 25 consecutive school days. The instructional period for the mathematics course was 55 minutes in length, except on Tuesdays where the instructional period was 41 minutes. There were a total of 5 Tuesdays in which direct vocabulary instruction was delivered to the whole class. Students engaged in making graphic organizers, poster boards, and comic strips, which addressed key vocabulary, embedded within the percentage word problems.

The remaining 20 instructional days were broken into two 25-minute intervention sessions. The researcher would begin the instructional period by facilitating the intervention to the seven participants within the treatment group. The first five minutes of the session began with the use of RLC. Participants were given objects, such as newspaper aids, selected items with and without price tags, and fake money, which would later be used to buy an item. The researcher and students engaged in discussion about the given item(s) and worked together to create a word problem, using the given objects and information. This portion of the intervention concluded with the researcher writing the student-generated word problem(s) on the board.

The second step in the treatment intervention was 15 minutes in length and incorporated the use of a four-step self-regulation checklist. Students were guided through the process of effectively applying the self-regulatory checklist until they were
able to independently apply the procedure on their own. The first step on the checklist required students to read the given word problem or to ask someone to read the problem to them. Once students had completed this task and had physically checked the first box, they could then proceed to the next question, which asked them to identify what the problem was asking for. Participants were required to write their conjecture next to the corresponding box. The third checkbox on the self-regulatory checklist asked students to determine if the given problem was a one-step or two-steps word problem. Students were required to circle their conclusion, which was based on their previous conjecture in step-two. Once the students had checked the third box, they could solve the percentage word problem using their previous conjectures on the self-regulatory checklist. The final step on the self-regulatory checklist was to check for understanding. If a student’s answer was illogical, they were expected to refer back to their self-regulatory checklist to complete steps one through four. Figure 1 provides an example of how the self-regulatory checklist was used within the study.

Figure 1

*Self-regulatory Checklist and Procedures*

The last part of the intervention phase was five minutes in length and focused on

<table>
<thead>
<tr>
<th>Checklist</th>
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</thead>
<tbody>
<tr>
<td>1) Have I read or asked someone to read me the problem?</td>
</tr>
<tr>
<td>2) Have I identified what I am solving for?</td>
</tr>
<tr>
<td>3) Is it a two-step problem or a one-step problem?</td>
</tr>
<tr>
<td>4) Does my answer make sense?</td>
</tr>
</tbody>
</table>
vocabulary development. Students were encouraged to share the sequential order of how they had effectively solved a given word problem using grade level content-specific math vocabulary. If a few minutes remained on the timer, the researcher would review the following 11 key vocabulary words: discount, tip, sales price, regular price, original price, total price, commission, retail price, interest, and sold. Once the 25-minute intervention was complete, the treatment group would switch positions with the control group.

The timer was reset for 25 minutes and the control group began their intervention session. The researcher engaged the control group in meaningful conversation about daily experiences such as going to the market, a restaurant, or watching their parents pay the bills. This part of the intervention was five minutes in length and concluded with the researcher asking the students to create a percentage word problem based on the previously discussed scenarios.

The second part of the control group’s intervention was 15 minutes in length. The researcher or students read the created word problems aloud and worked together to determine what the problem was asking for, as well as to identify the required procedural steps necessary in order to solve the problem. Once students arrived at a solution, the researcher encouraged students to conclude if their answer was reasonable. If the student felt their answer was incorrect, or they were unsure about their arrived solution, students were encouraged to re-do the problem or ask for help.

The last portion of the intervention was five minutes in length and consisted of the same vocabulary instruction provided to the treatment group. Using content-rich vocabulary, students were given an opportunity to share how they had effectively solved
the percentage word problems. They were also given direct instruction in the
aforementioned 11 vocabulary words.

When students were not participating in the intervention sessions, they were
receiving direct instruction from an interactive instructional math website. Students were
exposed to basic counting skills, such as counting money, adding and subtracting
decimals, simplifying fractions, and computing integers. During this computer
instructional time, students had headsets on and had their backs toward the intervention
session taking place in the front of the classroom. Two instructional aides were assisting
the students with any technological concerns or questions. The aides and the students
were directed before the study not to interrupt the researcher during the intervention
sessions and to hold questions until the 55-minute instructional period was over. This
minimized distractions and prevented any variation toward either treatment group.

**Data Collection**

The researcher used two forms of data collection methods: observing and
analyzing documents. Using more than one form of data collection will provide the
researcher with a sizeable amount of evidence to evaluate the research (McEwan &
as triangulation. They further posit the importance of using triangulation as a method to
prevent the researcher from drawing biased conclusions based on limited data. This
thesis study made multiple observations of the participants in various instructional
scenarios throughout the study. The researcher also analyzed student work samples, self-
regulatory checklist, and pre and post assessments as a second evaluative tool. The use
of more than one data collection methodology was used in this qualitative study in an effort to create a modified form of triangulation.

Validity and Reliability

The use of triangulation is used in qualitative research to test the reliability and validity of a study (Golafshani, 2003). Golafshani (2003) defines reliability as the ability to reproduce consistent results over time under similar methodologies. She describes validity as trustworthiness, or the intent of measuring what the researcher intended to measure. “Therefore, the quality of a research is related to generalizability of the result and thereby to the testing and increasing the validity or trustworthiness of the research” (Golafshani, 2003, p. 603). Through the implementation of modified triangulation the researcher sought to create a research study that was credible, trustworthy, and transferable.
CHAPTER 4: Results

Data were collected and analyzed to determine if vocabulary instruction, combined with self-regulation strategies, assist seventh grade students with LD develop problem-solving skills necessary to answer percentage word problems. Participants receive special education services in a Special Day Class (SDC) setting as determined by their Individualized Education Program (IEP). According to the urban school district’s IEP manual, students within a SDC setting are required to have access to any necessary modifications or accommodations that will support their involvement in and equal access to the general education curriculum. A SDC is taught by a specially credentialed teacher to assist students with LD with their basic psychological processing disorders. The goal of this qualitative study was to identify effective instructional methods, to assist students with LD gain skills to comprehend and compute mathematical word problems as outlined in the California Mathematics Content Standards (CMCS).

Within this case study, data were collected through pre- and post-assessments, informal observations, student work samples, and student self-regulation checklists. The self-regulatory checklist was developed to assist participants in the treatment group with monitoring their own learning and guide them through the mathematical processes of solving multiple step percentage word problems. Pre- and post-assessments were developed to quantifiably determine the results of the study. Two assessments were administered: a 10-question vocabulary test and a 12-question percentage word problem test. Student work samples and informal observations were also collected. The examiner determined student engagement and understanding by the analysis of student assignments and participation.
The participants in the treatment group were provided with scenarios, which simulated real life connections (RLC). They used newspaper advertisements and realia with price tags to replicate daily living scenarios. Participants in the control group were presented with verbal daily life scenarios to aid in student engagement and comprehension. The control and treatments group were presented with the same mathematical problems, though different methods were used to create the mathematical word problems.

The platform for this study is based on the California Department of Education (CDE) mathematics content standards. Participants are required under the No Child Left Behind Act (NCLB, 2001) to demonstrate proficiency on the California Standardized Test (CST) or California Modified Assessment (CMA) in mathematics by the year 2014. One of the underlining goals of this study was to provide students with LD with equal access and opportunities to content-based curriculum. The results answer the research questions presented within this study by identifying emerging themes, evidence to support those themes, and a discussion of the meaning derived from the evidence.

The School

The school is located in an urban community and consists of a large majority of low-income families. Eighty-nine percent of students qualify for a free or reduced lunch program, which is based on household income. The school ethnic make-up is 90% Hispanic, with the remaining 10% consisting of varied ethnicities. Each student, unless placed on an alternative curriculum, is taught grade level standards as mandated under NCLB (2001).
Participants of the Study

Thirteen participants took part in the study. Seven participants were included in the treatment group, and the remaining six were placed in the control group. Participants were separated into groups based on the school district’s special education eligibility criteria for students with a specific learning disability (SLD), which is defined as a disorder in one or more of the following processes: attention, auditory processing, visual processing, sensory motor skill, and cognitive abilities including association, conceptualization, and expression.

Mann-Krieger Middle School’s (MKMS) district eligibility criteria further emphasizes the psychological disorder impedes one or more of the following seven academic areas: listening comprehension, basic reading skills, oral expression, reading comprehension, written expression, math calculation, and math reasoning. These academic areas will be discussed to gain insight into the participants’ strengths and challenges. Student eligibility information was located within their SLD certification located within their IEP.

Participants in the treatment group were given the following pseudonyms: Darrel, Lola, Brice, Mickey, Meyer, Marco, and Melissa. They received 25-minute intervention sessions, which consisted of RLC, the implementation of a self-regulatory checklist to aid with solving percentage word problems, and vocabulary instruction. A general description of each participant is provided to gain context for their educational experience as it relates to their SLD and their linguistic capabilities and tendencies.
Darrel’s ethnicity is Black, and he is an English only student. His SLD certification indicates he has a severe discrepancy in all seven aforementioned academic areas. This discrepancy is primarily the result of a disorder in auditory processing.

Lola is Hispanic, and she is designated as limited English proficient. The primary language spoken at home is Spanish. Lola’s mother speaks very little English and prefers a translator be present when attending school meetings. Lola’s father speaks Spanish only. Her SLD certification shows a severe discrepancy in basic reading skills, oral expression, and written expression, which is a result of a disorder in visual processing, auditory processing, and cognitive abilities including association, conceptualization and expression.

Brice’s ethnicity is Black, and he is an English only student. He shows a severe discrepancy in the aforementioned six academic areas, excluding oral expression. His academic challenges are a result of a disorder in attention, visual processing, and sensory motor skills.

Mickey is a Hispanic student whose primary language is Spanish. Both of his parents are Spanish speaking only. Mickey displays a discrepancy in the aforementioned five academic areas excluding listening comprehension and oral expression. These discrepancies stem from his auditory processing disorder.

Meyer’s primary language is Spanish and he is Hispanic. His mother and father are able to communicate in English in simple sentences and phrases. Meyer struggles in the noted six academic areas except math calculation. This discrepancy is a result of a disorder in auditory processing and cognitive abilities, including association, conceptualization, and expression.
Marco is a Hispanic student designated as limited English Proficient. Both of his parents speak Spanish only. Marco struggles with attention, visual processing, and auditory processing, which hinder his academic performance in listening comprehension, written expression, math calculation, math reasoning, and reading comprehension.

Melissa’s ethnicity is Hispanic and her primary language spoken at home is Spanish. Her parents are Spanish speaking only. Melissa shows a severe discrepancy in the following academic areas: listening comprehension, written expression, math reasoning, and reading comprehension. This is a result of a disorder in attention and auditory processing.

Participants in the control group were given the following pseudonyms: Michael, Lucio, Jason, Ariel, Caroline, and Patty. They received 25-minute intervention sessions, which consisted of direct instruction with solving percentage word problems and vocabulary instruction. A general description of each participant is provided to gain context for their educational experience as it relates to their SLD and their linguistic capabilities and tendencies.

Michael is a Hispanic student with limited English proficiency. His mother and Father speak Spanish only. Michael displays challenges in all seven academic areas due to an auditory processing deficit.

Lucio’s primary language is Spanish, and he is of Hispanic origin. Both parents are Spanish speaking only. Lucio shows strengths in basic reading skills and oral expression. Attention, visual processing, and auditory processing hinder his performance in the other five academic areas.
Jason is Black, and he is an English only student. Jason shows a severe discrepancy in basic reading skills, math calculation, math reasoning, and reading comprehension. His psychological processing disorders are attention, visual processing, and auditory processing.

Ariel’s primary language is Spanish. She is a Hispanic student whose parents are Spanish speaking only. Ariel struggles with written language, basic reading skills, oral expression, reading comprehension, and math reasoning due to a disorder in auditory processing.

Caroline’s ethnicity is Black. She is an English only student. She struggles with reading comprehension due to a disorder in auditory processing and sensory motor skills.

Patty is a Caucasian student. She and her mother speak English only. Her psychological processing disorder is visual processing, which hinders her academic abilities in written expression.

**Scoring and Performance Analyses**

A correct answer or the correct mathematical problem solving process (PSP) is the criterion for evaluating whether students provided an appropriate solution to a specific problem items on the pre- and post- math assessment. The criterion was met if (a) the mathematics PSP and answer to the problem were correct; (b) only the correct answer was provided; or (c) the mathematics PSP was correct, but the answer was incorrect because of calculation errors. This scoring system was used because the focus was on the students’ representation of the major concepts of mathematic word problem solving, rather than on the mechanics of calculation.
The average for the pre-math assessment of the treatment group was .85 for the correct PSP and .14 for the correct answer though incorrect PSP. The average for the pre-math assessment of the control group was .33 for the correct PSP. Table 6 presents the scores for each participant on the post-math assessment indicating the number of items answered correctly with the correct PSP, as well as the number of items that used the correct PSP, but the answer was incorrect due to calculation errors.

Table 6

*Number of Items Answered Correctly on the Post Math Assessment*

<table>
<thead>
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<th>Treatment Group Post Test Results</th>
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<tbody>
<tr>
<td>Students</td>
<td>Correct Answer &amp; PSP</td>
<td>Correct PSP</td>
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<tr>
<td>Darrel</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Lola</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Brice</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mickey</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Meyer</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Marco</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Melissa</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control Group Post Test Results</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Michael</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Lucio</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Jason</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Ariel</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Caroline</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Patty</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

The average for the post math assessment of the treatment group was 4 correct answers with the correct PSP, and the average for the correct PSP was 1.8. The average for the post math assessment of the control group was 4.3 correct answers with the correct PSP, and the average for only the correct PSP was 2.1. The pre and post math
assessments were identical and included 12 of the following variety of questions: discount, sales price, interest earned, tip, commission, and total price.

Based on the data collected from the pre and post assessments, the treatment and control groups made significant math gains. On average, the treatment group increased its PSP score from .85 to 4 correct answers. This is an increase of 3.15 answers from the initial assessment. The control group increased its PSP from .33 to 4.3 correct answers. This is an increase of 3.97 answers on the final assessment compared to the initial assessment. On the pre math assessment, the treatment group scored .52 points higher on setting up the correct PSP. On the post math assessment, the control group scored .6 points higher with correctly setting up the PSP, and had a .3 point gain over the treatment group with problems that had the correct PSP and correct answer.

An identical pre and post 10-question vocabulary assessment was administered to determine if student deficiencies stem from lack of mastery in seventh grade math vocabulary content. The average number of questions answered correctly for the treatment group on the pre vocabulary test was 2.7, and 2.8 for the control group. The post vocabulary results were an average of 3.2 for the treatment group and 6.8 correct answers for the control group.

**Results: Research Question One**

Research Question One asked: Can vocabulary instruction combined with self-regulation strategies assist seventh grade students with LD in developing problem solving skills to answer percentage word problems? The goal of this research question and study was to identify performance outcomes among students with LD when solving mathematical word problems. The development of vocabulary knowledge is steeped in
research as a mitigating factor to assist students with LD in comprehension, which can aid in the understanding of mathematical word problems. Self-regulation strategies are another teaching methodology used to help students with LD monitor their own learning.

The results of the pre/post vocabulary and math assessment revealed an increase in academic performance among the treatment and control groups. The treatment group’s average vocabulary score was significantly lower than the control group, and the math assessment scores were slightly lower as well. From this research question, two themes emerged: vocabulary instruction and its relation to mathematical achievement when solving word problems, and the effects of self-regulation among a linguistically diverse and varied SLD population.

**Theme One: Vocabulary Instruction**

Based on the vocabulary assessment results, vocabulary instruction is a mitigating factor in student performance. The control group scored an average total of 3.6 more answers correctly than the treatment group on the post vocabulary assessment. This significant discrepancy in scores can be a resulting factor as to why the control group outperformed the treatment group on the math assessment portion of this study.

A contributing factor as to why the control group performed significantly higher on the vocabulary assessment is the fewer number of participants identified as limited English Proficient. Three out of six participants (50%) in the control group were English only students, compared to the treatment group, where two out of seven participants (28%) spoke English only. This evidence supports the notion that vocabulary comprehension amongst English Language Learners (ELL) with LD is an instrumental factor in student academic performance.
Important Indicator: Learning Disabilities as a Factor in Vocabulary Comprehension

In addition to the primary theme of vocabulary instruction, an important indicator emerged. The indicator stemmed from the participants’ SLD certification page, which identifies students’ academic strengths and challenges. It lists the following seven academic areas: listening comprehension, basic reading skills, oral expression, reading comprehension, written expression, math calculation, and math reasoning. The researcher identified three variations among the participants in the control group versus the treatment group. Five out of seven participants (71%) within the treatment group struggled with listening comprehension and basic reading skills, whereas only two out of six participants (33%) in the control group struggled in these two areas. In addition, six out of seven participants (85%) in the treatment group struggled with math reasoning versus three out of six participants (50%) in the control group. These large variations suggest that deficiencies in the aforementioned academic areas can be a contributing factor in the results of the study.

Theme Two: Self-Regulation

Results indicate that absence of self-regulation is not a significant contributing factor in this study as it examines low math performance. This is because of other potential linguistic, vocabulary comprehension, and SLD academic classification challenges experienced by the participants. The treatment group was able to apply the self-regulation checklist independently midway through the intervention, and the participants were able to follow the four sequential steps to assist with computing the percentage word problem. During the post assessment, the participants in the treatment group used their self-regulation checklist for all 12 problems.
Participants in both groups struggled with vocabulary comprehension, which hindered their ability to identify what the question was seeking. On many of the questions, participants were unable to determine if one or two steps were required to complete the problem. Participants in the treatment group were required to answer this question on their self-regulation checklist. Many of the students circled the incorrect number of steps on the post assessment checklist. Student work samples indicate further in-depth vocabulary instruction and a conceptual understanding of the math processes are necessary to assist seventh grade students with LD with solving percentage word problems.

Results: Research Question Two

Research Question Two asked: Can real life connections (RLC) assist seventh grade students with LD in obtaining a deeper understanding of percentage word problems? The literature presented in chapter two discussed the use of RLC as an instructional tool to assist students with making connections when solving mathematical word problems. This instructional approach is meant to trigger student engagement and prepare students with encounters presented in daily life.

Theme One: Real Life Connections

This study incorporated the use of RLC within the treatment group. Participants were given the opportunity to create and solve percentage word problems pulled from newspaper advertisements. Participants also engaged in a mock set up of a toy store within the classroom, where participants had to calculate the discount, sales prices, tax, as
well as total price of an item with toy money. Through these RLC, the treatment group had the opportunity to make connections and all participants showed active engagement.

During the intervention, the control group did not use realia to replicate the aforementioned scenarios. Instead, the control group was asked to visualize scenarios of purchasing an item at a store or earning interest at a bank. Many of the participants in the control group made connections with the mathematical word problems by sharing stories or providing examples of common scenarios related to the given problem. Students who did not voluntarily engage in discussion were encouraged by the researcher to share an example of a personal experience related to the math topic.

Based on informal observations of student engagement and participation, participants within the treatment group showed much more active involvement. Each participant in the treatment group was required to make mock purchases with his or her toy money and sort through advertisements to create mathematical word problems. However, there is no direct evidence supporting the posit that RLC combined with realia is an effective teaching methodology, which can assist seventh grade students with LD with independently solving grade level percentage word problems if vocabulary comprehension is not present.

**Conclusion**

The analysis revealed the absence of self-regulation was not a contributing factor to low math performance when linguistic challenges, vocabulary comprehension, and varied SLD academic classifications were present among participants. Further research is necessary to determine how to address the aforementioned challenges to improve the academic performance of seventh grade students with LD with academic deficiencies as
stated in their IEP or linguistic challenges presented among ELL. The implementation of RLC can be used as an effective tool to activate student engagement, which can aid in developing personal connections. However, for this case study, the implementation of RLC did not present quantifiable evidence to support academic improvement when compared to the absence of the intervention among the control group. Interventions presented in this study-effected improvement in academic performance among all participants.
Chapter 5: Discussion

This study examined the effectiveness of self-regulation strategies accompanied with real life connections (RLC) and vocabulary instruction to assist seventh grade students with LD. All participants in the study improved their mathematical performance in computing and solving percentage word problems. However, the treatment group performed lower than the control group on both the vocabulary and math assessment, which did not use self-regulation or RLC during the course of the study. The results yielded several mitigating variables as to why the control group outperformed the treatment group.

First, there were fewer English Language Learners (ELL) within the control group, which can account for the large discrepancy in scores on the vocabulary assessment between the two groups. In addition, variances within the academic areas highlighted on their specific learning disability (SLD) certification page revealed additional indicators for the study’s outcome. These results yielded pertinent information among educators assisting seventh grade students with LD. Instructional interventions, which incorporate strategies to assist ELL, factoring in varied SLD academic needs, will assist educators with meeting the high-stakes testing demands and standards put in place by No Child Left Behind (NCLB, 2001) and the Individuals with Disabilities Education Improvement Act (IDEIA, 2004).

Findings

The design of this study was rooted in research-based teaching methodologies to assist students with LD with their mathematical word problem solving performance.
Vocabulary development, self-regulation, and RLCs have provided positive outcomes with student academic success. The researcher combined the three aforementioned teaching strategies to create a potential math intervention to assist seventh grade students with LD in solving mathematical word problems. However, there were two main findings that indicate a need for instructional modification.

Since the majority of the participants within the treatment group were ELL, providing instruction in a dual language setting would have been beneficial, based on the heavy emphasis on vocabulary comprehension. A recent study by Francis, Lesaux, and August (2006) revealed that ELL in a bilingual program has yielded positive results in academic student learning outcomes, especially in reading programs. Since mathematical word problems rely heavily on reading comprehension, providing dual language instruction can be a means to accommodate the academic language barriers ELL encounter in the classroom.

A continuing theme in this finding revealed an additional factor related to ELL, namely, a large discrepancy on the vocabulary assessment scores between the control and treatment groups, beyond the scope of dual language ability. This then leads the reader to the area of Specifically Designed Academic Instruction in English (SDAIE). The researcher posits this variance in test scores is related to the large number of ELL in the treatment group. To remedy the language barrier in an in-depth vocabulary intervention, the students’ native language, or SDAIE, would be needed to assist ELL with comprehension on key math vocabulary terms. Current research noted in chapter two supports the theory of instructional methodologies focused largely on vocabulary development as an effective means to assist with comprehension. This study focused
heavily on computational skills, due to the participants’ lack of skills with basic operations, such as multiplying double-digits, or basic re-grouping skills. It would be beneficial to provide vocabulary instruction to students with a thorough understanding of these basic mathematical operations, before teaching multiple-step percentage word problems steeped in vocabulary comprehension.

**Implications for Practice**

The implementation of self-regulation, coupled with RLC, is not an influential factor for mathematical word problem solving among seventh grade students with LD when other variables are present. Self-regulation and RLC are tools to use when solving mathematical word problems. Additionally, these strategies should be incorporated based on the developmental needs of the students. For this study, participants lacked a firm understanding of basic math operations and vocabulary comprehension, which hindered them from carrying out the aforementioned two strategies effectively.

The findings of this study have several implications for practice. First, educators and policy-makers will be well advised to consider modifying instructional interventions to meet the needs of their student population, such as determining the appropriate language model within the classroom. There are several instructional programs for ELL that occupy a continuum with an English-only modal at one end, and a bilingual modal at the other (Moughamian, Rivera, & Francis, 2009). These instructional models are designed to create a beneficial learning environment for ELL. However, it is often the decision of the school district or school site to decide which model it adopts. Secondly, it is important teachers provide students with LD scaffolding techniques when incorporating self-regulation strategies independently. Students should be informed on
how to effectively use and transfer self-regulation tools to assist them with varied problem solving situations.

**Future Research**

A math intervention specifically designed to address the participants’ SLD academic challenges, as identified on the SLD certification page located within a student’s IEP, is an area for future research. A majority of the participants within this study struggled with listening comprehension, basic reading skills, and mathematical reasoning. It would be advisable to concentrate on the three aforementioned academic challenges to develop an intervention which either draws on the students’ strengths as indicated on their SLD certification page, or to develop an intervention which supports the aforementioned three categories.

There is a need for continued investigation of the processes and strategies appropriate when teaching students with LD. In this study, the control group displayed fewer challenges with listening comprehension, basic reading skills, and mathematical reasoning, whereas the treatment group had a higher number of participants who struggled in these academic areas. The results indicate there is a direct correlation between a participant’s SLD academic classification(s), and his or her academic performance in percentage word problems. Furthermore, the treatment group also had a greater number of ELL, and these students are more inclined to experience academic challenges with language, such as basic reading skills and listening comprehension.

There is a need for stronger research designs and research reporting within the field of math interventions for secondary school students with LD, as well as ELL, who are classified as having a SLD. Researchers and educators need to thoroughly examine
the participant’s SLD classification(s): attention, auditory processing, visual processing, sensory motor skill, and cognitive abilities including association, conceptualization, and expression as well as the seven academic areas in which their psychological disorder may impend. In addition, linguistic capabilities should also be observed, in order to develop an appropriate intervention specifically designed to meet the needs of their student population.

**Conclusion**

Overall, this study indicates the need for more individualized instructional modifications when providing instruction to students with LD who may or may not have linguistic challenges. Self-regulation and RLC are not contributing influences in student academic success when solving seventh grade percentage word problems, if other variables are more prominent, such as limited computation skills, limited vocabulary comprehension, and linguistic and academic challenges. Educators need to continue to develop instructional strategies that will accommodate the needs of these varied challenges in order to meet high-stake testing demands and assessment standards put in place by NCLB (2001).
References


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