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Effects of Peer-Mediated Vocabulary Intervention on Science Achievement of Seventh Grade Students With and Without Learning Disabilities

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EFFECTS OF PEER-MEDIATED VOCABULARY INTERVENTION ON SCIENCE ACHEIVEMENT OF SEVENTH GRADE STUDENTS WITH AND WITHOUT LEARNING DISABILITIES

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by
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Presented to:
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ABSTRACT

Vocabulary knowledge is critical for accessing content-area information for students with learning disabilities who receive instruction in general education content-area classes. Therefore, the purpose of this study was to examine the effects of a peer-mediated science vocabulary intervention in general education classrooms on academic achievement of seventh-grade students with and without learning disabilities. A quasi-experimental design with multiple pre- and posttest measures was used to determine the effects of the intervention and whether the intervention was differentially effective for students with learning disabilities compared to their nondisabled peers. The study included 8 teacher participants and 675 student participants in 41 classes. The peer-mediated science vocabulary intervention took place two days per week with a third day for weekly assessments. Students learned 8 new science terms per week by working with their partner using a student routine and researcher developed science vocabulary cards. Results indicated that students in the peer-mediated vocabulary intervention condition outperformed students in the non peer-mediated condition on three academic measures including vocabulary assessments, science standards-based assessments, and numerical grades. However, students' weekly vocabulary growth on science curriculum-based measures was similar for students in both groups. Teachers who implemented the peer-mediated science vocabulary intervention reported overall positive perceptions of the effectiveness and feasibility of the intervention. Students who participated in the peer-mediated science vocabulary intervention indicated they enjoyed working with a peer but reported less favorable opinions regarding the general vocabulary procedures.

DEDICATION

To my father Al Green, who said I could be anything I wanted to be.

and

To American educators everywhere-from preschool teachers to university professors. It is only we who know how difficult and complex our jobs truly are. It is my hope that one day we will get the recognition and respect we so deeply deserve.

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CHAPTER ONE

INTRODUCTION

Two key pieces of legislation have significant implications for students with disabilities in the general education curriculum. The amendments to the Individuals with Disabilities Education Act (IDEA) of 2004 require students with disabilities to participate in the general education curriculum to the maximum extent possible. Furthermore, the No Child Left Behind Act (NCLB) requires that all students, regardless of disability status, participate in standards-based assessments required by states to assess adequate yearly progress. Thus, students with disabilities participate in general education classes at increasing rates. According to the 28th Annual Report to Congress on the Implementation of IDEA (U.S. Department of Education, 2009), during the fall of 2004, 52% of all students with disabilities were educated in special education classes less than 21% of the school day. Almost half (44%) of all students with disabilities have learning disabilities (LD) and 59% of students with LD spend 80% or more of their time in general education classes (Cortiella, 2009).

Increasing numbers of students with LD in general education classes present unique challenges to teachers. General education teachers who teach content-area classes are expected to provide instructional opportunities to allow all students, including those with LD, to become competent in the subject matter and to participate in the statewide standards-based assessments.

Academic outcomes for students with LD are discouraging. Only 61% of students with LD received a regular high school diploma in 2007 (Cortiella, 2009). In addition, 14% of students with LD received a certificate of completion, while 24% of students with LD dropped out of school completely (Cortiella, 2009). Not surprisingly, academic achievement of students with LD is significantly lower than that of their non-disabled peers. According to the National Longitudinal Transition Study-2 (NLTS2; Wagner, Newman, Cameto, Levine, & Garza, 2006) at least one-fifth of all students with LD are five or more grade levels behind the grade in which they are enrolled in both mathematics and reading. Almost half of students with LD test more than three grade levels behind, and nearly one-fourth of students with LD are at least one grade level behind (Wagner et al., 2006). In addition, the achievement gap between students with LD and those without disabilities widens as students progress through school (Cortiella, 2009). The achievement gap is significant for the subjects of mathematics and reading, and because learning in the content areas is dependent on established skills in both mathematics and reading, the achievement gap is significant in the content areas as well.

In this chapter, three critical issues that impact learning in content areas for middle school students with LD are discussed: (a) areas of deficit that impact content-area learning, (b) features of content-area textbooks that affect content mastery, and (c) features of teacher preparation that may limit access for students with LD. In addition, national assessment data of achievement in science for students with and without LD is discussed and the importance of teaching science is highlighted.

Areas of Deficit That Impact Content-Area Learning

Because general education content-area teachers are expected to teach all students, it is important to consider learning traits of students with LD that may present challenges for teachers in the general education setting. Academic skill deficits can result in problems for students with LD because students need to use those skills to master new material in content-area classes (Smith, Dittmer, & Skinner, 2002). Students with LD often experience difficulties with language and literacy (Scruggs, Mastropieri, & Boon, 1998; Scruggs & Mastropieri, 1993), which is especially important considering the complex demands in content-area classrooms. Students in science classes, for example, need to learn science content, such as the scientific method and research methods, and to do so, they need content-area literacy skills, such as reading fluency, vocabulary, and comprehension (Troia, 2006).

Although educational technology has advanced considerably over the years, much content-area instruction is still presented using print-based resources (Boardman, Roberts, Vaughn, Wexler, Murray, & Kosanovich, 2008). Despite their deficits in the area of language and literacy, students with LD must read to learn in the content-areas. Content-area reading can be challenging even to proficient readers (Harmon, Hedrick, & Wood, 2005), and students who struggle in reading face serious challenges (Lee & Spratley, 2010). In content-area classes, students are not only expected to learn the content material, they are expected to do so in ways that may be extremely difficult for struggling readers. For example, students with LD and struggling readers often have difficulty reading complex content materials, comprehending reading on their own, reading content-area text with fluency, and decoding and defining complex vocabulary terms (Moje & Tysvaer, 2010). In particular, students with disabilities struggle with comprehension, pronunciation of multisyllabic words, background knowledge (Carlisle &

Andrews, 1993; Carnegie Council on Advancing Adolescent Literacy, 2010), text structure, fluency (Parmar & Cawley, 1993), and vocabulary knowledge (Carlisle & Andrews, 1993; Harmon et al., 2005; Shepard & Adjogah, 1994; Lee & Spratley, 2010).

According to the National Reading Panel Report (2000), vocabulary is a critical aspect of reading instruction. The larger a reader's vocabulary, the easier it is to comprehend the text (National Reading Panel, 2000). Lack of vocabulary knowledge can be particularly problematic for students with LD. Vocabulary learning is affected by language deficiencies and lack of reading practice (Bryant, Goodwin, Bryant, & Higgins, 2003), which are typical problems for students with LD. Limited vocabulary knowledge leads to limited comprehension of written material, because the relationship is considered reciprocal (Stanovich, 1986). Complicated vocabulary terms are interwoven within content-area text, and students with LD must read and understand these terms to be able to learn from the text (Harmon et al., 2005). During a typical school day, students are inundated with new vocabulary terms that represent unfamiliar concepts. These terms may be low-frequency words that do not appear in other contexts or content-areas. Students' limited exposure to low-frequency words may prevent students from mastering the vocabulary terms (Harmon et al., 2005). Direct instruction of vocabulary coupled with multiple exposures to the new terms, teaching vocabulary in rich contexts, and active student engagement are important in vocabulary instruction (National Reading Panel, 2000) and are necessary for students to fully comprehend content-area material. When students with LD are asked to read to learn content, they are often unable to do so due to lack of vocabulary knowledge (Harmon et al., 2005), and lack of instruction in vocabulary attributed in part to the complex demands of middle and high school content instruction (Troia, 2006).

Science Textbooks

Along with limited content-area literacy skills, textbooks often pose problems for students with LD in general education science classrooms, and teachers tend to depend on textbooks to teach science concepts (McCarthy, 2005; Parmar & Cawley, 1993; Scruggs & Mastropieri, 1993). Some estimates indicate that 75 to 98% of classroom activities are organized around textbooks (Harniss, 2006). Students with LD experience difficulties with language and literacy, and when teachers depend heavily upon textbooks for instructional purposes without additional supports or scaffolding, students with LD will likely struggle. Science textbooks are particularly difficult for students with disabilities because they often include high readability levels (McCarthy, 2005), dense presentation of information (Carlisle & Andrews, 1993), presentation of unfamiliar concepts and vocabulary terms at a quick pace (Carlisle & Andrews, 1993; Harmon et al., 2005), and inadequate coverage of key background knowledge (Woodward & Noell, 1991). Content-area texts often present difficult concepts based on an assumption that students have prior knowledge that some may not have acquired (Carlisle & Andrews, 1993). For example, an individual's comprehension, attention, and point of view may be affected by prior knowledge (Lee & Spratley, 2010). Additional problems for students with LD in content-area textbooks include students' inability to decode text, lack of instruction in how to read science textbooks (Carnine & Carnine, 2004), and teachers' limited use of sound instructional principles, such as activating prior knowledge and previewing concepts and vocabulary (Woodward, 1994). Prior knowledge includes “words and word forms, sentence structure or syntax, text structures or genres, and topics” (Lee & Spratley, 2010, p.3). When these sources of knowledge are not activated prior to instruction, students often struggle with comprehension, especially in content-area texts. Reading in content-area textbooks presents difficulty for struggling readers because when students do not understand the text, they are unlikely to learn the content, and when they do not know the content, they are unlikely to understand the text (Lee & Spratley, 2010). Learning from textbooks requires struggling readers to know something about the content, concepts, and vocabulary ahead of time; consequently, when teachers do not activate prior knowledge by previewing concepts and vocabulary, students’ learning of content-area material is impacted.

Quality of Teacher Instruction

A third critical issue that may impact content-area instruction is quality of teacher education. Although students with disabilities participate in general education classrooms at increasing rates, many teacher education programs have not adjusted their preparation programs to address their teacher candidates’ needs for effective inclusive strategies. Content-area teachers often lack specific training in research-based strategies and interventions to address the needs of students with disabilities. Subsequently, teachers’ lack of training may limit the achievement of students with disabilities within the general education setting (Cawley, Hayden, Cade, & Baker-Kroczynski, 2002; McCarthy, 2005; Munk, Brucker, Call, Stoehrmann, & Radandt, 1998). In a study by Conderman and Johnston-Rodriguez (2009), general education teachers reported feeling poorly prepared to handle students with disabilities in their classrooms in skills, such as making accommodations and modifications to the curriculum, providing access to the general education curriculum, using individualized assessments, and monitoring progress. In addition, some respondents reported that skills in making modifications or accommodations were less important than other skills related to their teaching (Conderman & Johnston-Rodriguez, 2009). Teachers' lack of knowledge about special education procedures and requirements is often a problem for students with LD in the general education classrooms because instructional accommodations and modifications are critical in meeting the legal requirement to include students with disabilities in the general curriculum to the greatest extent possible.

Lack of training in effective research-based practices for teaching students with LD is especially disconcerting in the content-areas. Content-area teachers are specifically trained as experts within their content domain, but they often lack the skills needed to teach successfully the content material to students with disabilities (Carnegie Council on Advancing Adolescent Literacy, 2010; Scruggs et al., 1998). Teaching students with disabilities requires specific knowledge about scientifically based instructional methods, progress monitoring, and accommodations and curricular modifications. According to Scruggs et al. (1998), teachers agree that it takes training, skill, time, resources, and support to teach science content effectively to students with disabilities. Furthermore, training, skill, time, resources, and support are provided inconsistently to science teachers (Scruggs et al., 1998). Content-area teachers need support, resources, and targeted professional development to teach effectively students with disabilities. Specifically, professional development for science content and instruction, as well as reading instruction, is important for science teachers who teach students with disabilities (Carnine & Carnine, 2004). Content-area teachers need training in interventions that can promote students' content literacy and allow students with LD to succeed within the general education classroom (Deshler et al., 2001). Sound research-based interventions are necessary not only to increase academic achievement for students with disabilities in general education classrooms but also for general education teachers who may not have been trained to teach students with disabilities. Many general education teachers who lack specific training in instructional strategies and pedagogy may need strategies and interventions to address a range of students' needs.

Science Achievement

Students' academic deficits, inconsiderate content-area texts, and content-area teachers' limited knowledge and use of effective pedagogical and instructional strategies often inhibit content-area learning for students with diverse learning needs. It is important to consider the impact of these and other factors on the science achievement of students with disabilities. The NLTS-2 reports that 74% of secondary students with LD participate in general education science classes (Newman, 2006). Although students with disabilities participate in general education classrooms for science, their academic performance is not commensurate with that of their same-age, non-disabled peers.

The National Assessment on Education Progress (NAEP) (Grigg, Lauka, & Brockway, 2006) data show that all students' academic performance declines in science as they progress throughout their school careers. Forty-five percent of students with disabilities in fourth grade scored basic or above in science, while 70% of students without disabilities scored basic or above. In eighth grade, only 27% of students with disabilities scored basic or above in science, while 62% of students without disabilities scored basic or above. The differences here are notable, but not entirely surprising due to the possible mismatch of general education instructional techniques and learning characteristics of students with disabilities (Scruggs et al., 1998). In addition, NAEP data show that of 12th grade students with disabilities, only 17% scored basic or above in science, while 57% of 12th grade students without disabilities scored basic or above. While basic and above scores of 57% for students without disabilities is less than adequate, it is much greater than the 17% of students with disabilities who score basic or above. This 40% difference between students with and without disabilities is significant. Although scores for students without disabilities have declined at steady rates, students with disabilities have declined at a much more substantial rate.

In addition, scores of basic on the NAEP indicate the student has only partial mastery of the fundamental knowledge and skills in science content; whereas, a score of proficient indicates the student has shown "solid academic performance and demonstrated competency over challenging subject matter" (Grigg et al., 2006, p. 5). Consequently, educators should not be satisfied with scores of basic, or that indicate students have gained minimal knowledge to pass the assessment. In order to increase student performance at middle and high school levels, instruction in science content must address the unique learning characteristics of students with disabilities.

Science achievement for students with disabilities is dismal. Deficits in content-area literacy skills and limited vocabulary knowledge likely contribute to the poor outcomes for students with disabilities in science. Because increased numbers of students with disabilities, and LD specifically, participate in general education content-area instruction, such as science, teachers need effective strategies to address their unique learning needs. However, general education teachers often lack training and knowledge in research-based strategies to address students' limited vocabulary knowledge and literacy skills. Therefore, it is important to evaluate instructional interventions that address students' limited vocabulary knowledge and literacy skills and that are feasible within the general education setting.

Purpose of the Study

The purpose of this study was to evaluate a science vocabulary intervention for students with and without LD who receive science instruction from general education teachers in general education classrooms. This intervention was designed to incorporate the use of direct instruction of key vocabulary by a peer, multiple exposures to terms, vocabulary instruction in rich contexts, and active student engagement while learning the content, all of which are deemed important parts of vocabulary instruction (National Reading Panel Report, 2000). The impact of the intervention is examined for students with and without disabilities because it is important to find research-based interventions that work not only for students with LD but also for typical students in general education classrooms.

Research Questions

1. What are the effects of a peer-mediated vocabulary intervention in the general education setting on the science achievement of students with and without LD on quarter numerical grades, slope of improvement on weekly vocabulary-matching curriculum-based measurement (CBM), a vocabulary measure that assesses terms taught throughout the nine weeks, and a seventh-grade science standards-based assessment?

2. Is the peer-mediated vocabulary intervention differentially effective for students with LD compared to their nondisabled peers?

3. What are the attitudes of students with and without LD toward the peer-mediated vocabulary intervention in the general education science classroom?

4. What are general education teachers' perceptions of the benefit of the peer-mediated vocabulary intervention for students with and without LD in their classes?

Significance of the Study

Science has been identified as an important area of instruction for students with disabilities (Cawley, 1994; Mastropieri & Scruggs, 1992; Mastropieri, Scruggs, & Boon, 1998; McCarthy, 2005; Nolet & Tindal, 1994; Patton, 1995; Shepard & Adjogah, 1994; Woodward, 1994). Science can promote thinking and problem-solving abilities (Woodward, 1994), opportunities to participate in general education classrooms (Carlisle & Andrews, 1993), preparation for college, preparation for science-related careers (Scruggs, Mastropieri, & Boon, 1998), and transition into the life and work of adulthood (McCarthy, 2005). Students with disabilities often experience difficulties in science with textbook reading and comprehension (Woodward, 1994; Carnine & Carnine, 2004; Woodward & Noell, 1991; Parmar, Deluca, & Janczak, 1994), vocabulary (Carnine & Carnine, 2004; Harmon et al., 2005; Shepard & Adjogah, 1994), background knowledge and strategies for in-depth learning (Woodward & Noell, 1991, Carlisle & Andrews, 1993), limited opportunities for responding and low rates of responding in class and during group activities (Munk et al., 1998; Scruggs, Mastropieri, & Boon, 1998).

Academic skill deficits, frequent use of inconsiderate texts, and lack of teacher preparation to teach students with LD combine to make it difficult for students with LD to achieve in general education science classrooms and contribute to low levels of science achievement. Clearly, interventions in general education science classrooms are important for students with LD to master science content. When struggling learners do not have the skills necessary to understand the complex material in a science curriculum, instructional changes are needed to allow them opportunities for learning consistent with that of their nondisabled peers. Because science achievement data show that all students' performance in science declines over the course of their school careers, teachers need research-based interventions that are likely to increase academic outcomes in science for students with and without disabilities. Thus, information about available research-based interventions that address the needs of students with and without disabilities in science classrooms is important. This study is important because it specifically addresses an intervention that may increase academic outcomes in science for students with and without LD.

CHAPTER TWO

LITERATURE REVIEW

The purpose of this chapter is to examine the literature regarding research-based strategies and interventions in science and their impact on academic outcomes for students with LD in general education settings. This chapter includes a brief discussion of the importance of vocabulary instruction for adolescents, implications for vocabulary instruction for students with LD, and a brief discussion of the research on and benefits of classwide peer tutoring. The primary focus of this chapter is a systematic review of current literature that involves interventions with academic outcomes in science for students with LD. This review includes a description of six studies that met inclusion criteria, synthesis of findings, and implications for future studies.

Importance of Vocabulary Instruction for Adolescents with LD

The importance of vocabulary in reading instruction and achievement has long been recognized within the academic community (National Reading Panel, 2000). Vocabulary knowledge is highly correlated with reading comprehension and academic success (Boardman et al., 2008; Moje & Tysvaer, 2010; National Reading Panel, 2000; NICHD, 2007). Students who understand word meanings encountered during reading are more likely to comprehend the material they read (Boardman et al., 2008). Research indicates that good readers have strong oral, aural, and print vocabulary (NICHD, 2007). Oral vocabulary concerns the words used when speaking; aural vocabulary refers to the understanding of words when someone is speaking; print vocabulary refers to words in print that are used in reading and writing (NICHD, 2007). Print vocabulary can be difficult for students to attain, particularly when they struggle in reading, do not read often, and do not engage in rich experiences with words that can result in incidental word learning (Boardman et al., 2008).

Although research suggests there is not a single best way to teach vocabulary (NICHD, 2007), the National Reading Panel Report (2000) findings point to instructional practices that have been shown to improve students' vocabulary knowledge. These practices include computer instruction, incidental learning in context or from listening to others read, repeated exposure in authentic contexts, pre instruction of vocabulary terms prior to reading, and restructuring of text materials. In addition, the National Reading Panel (2000) found that comprehension is affected positively by vocabulary instruction.

Middle and high school students face serious academic challenges when they have poor or underdeveloped vocabulary knowledge. Adolescent learners need strategies for unknown word recognition, which is especially important considering the increasingly difficult text they read (Boardman et al., 2008) and the amount of content they are expected to master in middle and secondary school. As students advance in school, literacy demands change and levels of intensity increase (Carnegie Council on Advancing Adolescent Literacy, 2010). In the content-areas, text and terminology are often technical and abstract (NICHD, 2007) and increasing demands are made by texts on all-purpose academic vocabulary (Carnegie Council on Advancing Adolescent Literacy, 2010). Struggling readers who lack vocabulary knowledge are likely to experience problems with comprehension of content-area texts (Carnegie Council on Advancing Adolescent Literacy, 2010; NICHD, 2007). For example, the term photosynthesis would be common to a science text and is a very technical, abstract, and conceptually based term. For students to understand the meaning of photosynthesis, several other vocabulary terms are necessary to fully understand the concept; chlorophyll, chloroplast, protein, organic compound, and organelle are all critical to the understanding of photosynthesis. These technical, abstract, and conceptually based science vocabulary terms place high demands on comprehension and word learning for all students, but especially students who have poor or underdeveloped vocabulary knowledge. When students are unable to understand vocabulary terminology and the concepts the terms represent, comprehension can be deficient and student achievement will likely be impacted.

Implications for Vocabulary Instruction for Students with LD

Many adolescents with disabilities have difficulties in reading. They may be confused easily by large amounts of vocabulary and content presented to them and may have difficulty differentiating between core concepts and interesting details (Lockheed, 1990). Repeated exposure to vocabulary terms in multiple oral and written contexts is important to ensure deep level understanding (Kamil et al., 2008). Some suggest that it may take as many as 17 exposures to a single vocabulary term to learn it (Kamil et al., 2008). In addition to repeated exposures, students need opportunities to use new vocabulary terms in a range of contexts to ensure understanding of productive meanings of terms (Kamil et al., 2008).

Several considerations impact the effectiveness of vocabulary instruction and subsequently comprehension (Boardman, 2008; Carnine & Carnine, 2004). First, terms should be carefully selected to improve access to the content for students with LD.

Vocabulary terms should be selected on the basis of their importance in the particular content area (Kamil et al., 2008). In addition to careful selection of terms, allocated instructional time to preteach critical terms is central to students' success in content-area learning. A final element that impacts students' content-area learning is the frequent and systematic review of the terms. Students need multiple opportunities for practice and exposure to the terms to be able to fully understand the terms and concepts related to them.

Explicit instruction in vocabulary terms with pretests, practice, and posttests is important (Carnine & Carnine, 2004). Explicit instruction is essential for students to learn the meaning of new words and to strengthen students' independence at constructing meaning of text (Kamil et al., 2008). Graphic depictions of vocabulary terms that are paired with direct instruction are promising in promoting word meaning knowledge and comprehension of reading passages (Bryant et al., 2003). Graphic organizers require students to classify information, establish relationships, and draw inferences as they read and discuss text (Woodward, 1994). Classifying information, establishing relationships, and drawing inferences promotes higher order thinking about the concept or vocabulary term, which aids in connections to other information and promotes recall (Woodward, 1994). Underlying concepts and their relationships to one another are important in teaching vocabulary (Bos & Anders, 1990). Bos and Anders found that detailed vocabulary instruction emphasizing concepts and relationships facilitated reading comprehension for students with LD.

Classwide Peer Tutoring

When considering interventions that have potential for improving outcomes for students with LD in content-area classes, it is important to examine practices that have demonstrated effects in general education settings. Identification of scientifically validated academic interventions for students with disabilities participating in general education classrooms is difficult because research in general education classrooms is complex (McMaster, Fuchs, & Fuchs, 2006). Studies that investigate the effectiveness of academic interventions in general education classes are difficult because they typically must be conducted on a large scale and require substantial resources and support (McMaster et al., 2006). One intervention for students with disabilities that has been examined in general education classrooms is classwide peer tutoring. Classwide peer tutoring has a 30-year research base and has repeatedly demonstrated its effectiveness for students with disabilities and low-achieving students in subjects such as math, reading, social studies, spelling, and vocabulary (Hughes & Frederick, 2006; Kourea, Cartledge, & Musti-Rao, 2007). In addition, Scruggs and Mastropieri (2007) have found effective results for peer tutoring in inclusive science classrooms. Research on peer tutoring has demonstrated effectiveness in classrooms from preschool to high school, for a variety of student populations, and within inclusive classrooms (Heron, Villareal, Yao, Christianson, & Heron, 2006; Kourea et al., 2007). Benefits of classwide peer tutoring include increased practice and student engagement (Kourea et al., 2007; Heron et al., 2006; Hughes & Frederick, 2006; Calhoon, 2005; Scruggs & Mastropieri, 2007), increased opportunities to respond (Harper & Maheady, 2007; Heron et al., 2006;

Stenhoff & Lignugaris/Kraft, 2007), immediate corrective feedback and increased accuracy of responses (Harper & Maheady, 2007; Stenhoff & Lignugaris/Kraft, 2007; Calhoon, 2005) peer interaction and social skills practice (Harper & Maheady, 2007; Kourea et al., 2007), and alternative formats to teacher-led instruction (Calhoon, 2005; Harper & Maheady, 2007; Marchand-Martella, Martella, Bettis, & Blakely, 2004). Peer-tutoring research demonstrates consistent improvements on academic and social outcomes and is feasible in both general and special education classes. Positive outcomes related to peer tutoring make it a well-suited instructional practice for use in inclusive and self-contained classrooms (Harper & Maheady, 2007).

Studies on Science Interventions Reported in the Literature

Several factors have been identified that support or limit success for students with disabilities in general education science classes. Students' academic deficits in language and literacy often hinder their achievement in content-area classes. In addition, science curricula include complex and difficult material that may be difficult for students with disabilities to understand. Research-based instructional interventions are necessary to allow students with LD in general education classrooms the same opportunities for learning as their nondisabled peers, and to increase academic outcomes in science for students with disabilities. Peer tutoring is one intervention that has the potential for supporting students with disabilities across a range of academic areas. However, a systematic review of the literature to identify specific interventions to address the learning needs of students with disabilities in general education science classes has not been conducted. Therefore the purpose of this section is to present a comprehensive review and synthesis of the current literature on academic interventions in general education science classrooms for students with mild disabilities.

To locate articles to include in this review, databases searched were ERIC, PsychInfo, and Academic Search Premier using the following key words separately and in various combinations: *science, special education, interventions, science instruction, learning disabilities, middle school, elementary, high school, junior high, intermediate grades, mainstreaming, inclusion, general education, and disabilities*. In addition, a hand search was conducted of the following journals: *Exceptional Children, The Journal of Special Education, Remedial and Special Education, Journal of Learning Disabilities,* and *Learning Disability Quarterly* beginning with the earliest issue from the years 1992 to 2010. The reference lists of identified articles were also examined for additional references. A total of 23 studies were identified through this search process. Fifteen of these studies were found through the electronic search, six were found through the hand search, and one was found through the ancestral search.

Studies were selected for inclusion in the review if they: (a) were published in a peer-refereed journal, (b) examined interventions in general education science classrooms, (c) included students with mild disabilities as participants, (d) utilized an experimental, quasi-experimental, or single subject research design, and (e) included dependent measures of academic outcomes in science. These criteria were chosen because they address both quality of existing research and the focus of the current study. Of the original 23, six studies met the criteria for inclusion in this review. All studies were coded for the following: (a) participant characteristics, (b) setting, (c) experimental design, (d) type of intervention, (e) random assignment, (f) experimental groups, and (g) dependent measures of academic outcomes.

Studies that took place in clinical or self-contained settings were excluded (Bakken, Mastropieri & Scruggs, 1997; Mastropieri, Scruggs, Boon, & Carter, 2001; Mastropieri, Scruggs, Levin, Gaffney, & McLoone, 1985; McCarthy, 2005; Rogevich & Perin, 2008; Scruggs & Mastropieri, 1992; Scruggs, Mastropieri, Bakken, & Brigham, 1993; Smith, Dittmer, & Skinner, 2002) because the emphasis of this research is on interventions that are likely to be successful in general education settings. Three studies were excluded because they used ethnographic case studies or formative design; these three studies did not include comparison groups (Bodzin, Waller, Santoro, & Kale, 2007; Palincsar, Collins, Marano, & Magnusson, 2000; Palincsar, Magnusson, Collins, & Cutter, 2001). Additional studies were excluded because they did not compare interventions (Nolet & Tindal, 1994, Nolet & Tindal, 1995), did not involve science content (Mastropieri, Scruggs, & Fulk, 1990), described an analysis of curriculum without an experimental group (Tindal & Nolet, 1996), or did not specifically include students with disabilities (Guastello, Beasley, & Sinatra, 2000).

Results

Six studies reporting the results of experimental or quasi-experimental research studies met the inclusion criteria. Table 1 provides descriptive information for each study, including (a) participants, (b) intervention, (c) intervention category, (d) setting, (e) experimental design, (f) dependent measure, and (g) results. Descriptions of reviewed studies are presented, followed by a summary of results across overall findings and implications for further research.

McDuffie, Mastropieri, and Scruggs (2009). McDuffie, Mastropieri, and Scruggs (2009) conducted a school-based study in seventh grade general education science classrooms. A total of 203 students participated, 62 received special education services, including 48 students with LD and 14 with other mild disabilities. The study included eight classes and seven teachers. Of the eight classes, four were co-taught, and four classes were not co-taught. Within the four non co-taught classes, two classes were randomly assigned to the experimental condition of peer tutoring and two continued traditional instruction. Within the four co-taught classes, two classes were randomly assigned to the experimental condition of peer tutoring and two continued traditional instruction. Experimental and control groups each had two co-taught classes and two non co-taught classes.

The eight-week intervention consisted of peer tutoring in major concepts and vocabulary from each of the five units of science instruction based on state standards. Ten-minute sessions occurred each morning in place of traditional warm-up activities. Students were paired with similarly achieving peers. Peer-tutoring materials consisted of "fact sheets" with 10 questions and answers per page. Students and teachers were trained by the researchers in peer-tutoring procedures and use of materials to ensure fidelity of implementation. Students in the control group received traditional teacher- directed instruction and traditional warm-up activities.

Dependent measures included first quarter science grades, end-of-unit tests, researcher-developed pre- and posttests on science content, and surveys about attitudes towards science, peer tutoring, and co-teaching. Researcher-developed pre- and posttests included production items (open-ended, short answer questions) and identification items (multiple-choice questions).

Results showed that students in the peer-tutoring condition outperformed students in traditional academic instruction on end-of-unit tests, but not on the researcher-developed cumulative posttest. On the cumulative posttest, students in the experimental condition outperformed students in the control group on the identification items, but not on the production items. Mean scores on unit tests and cumulative posttests were reported for students with and without disabilities; however specific analyses comparing the two groups was not reported.

Mastropieri, Scruggs, Mantzicopoulos, Sturgeon, Goodwin, and Chung (1998). Mastropieri, Scruggs, Mantzicopoulos, Sturgeon, Goodwin, and Chung (1998) used a qualitative/quasi-experimental design to examine the impact of activities-oriented instruction on students' performance in science in three general education classes. A total of 75 fourth-grade students were involved in the study, five of whom received special education services. The intervention occurred three times per week across seven weeks. All students with disabilities included in this study participated in the treatment group, and according to the authors, random assignment of control and experimental groups was not possible.

The intervention consisted of activity-based instruction in the general education classroom. In the treatment condition, students were placed into small groups based on teacher knowledge of how well they would work together. Students worked together to make an aquarium/terrarium, or "ecocolumn" in each group and throughout the science unit made observations, predictions, compared observations with predictions, and recorded observations and conclusions. Then, small groups met in pairs and conducted experiments using one ecocolumn as a control and one as experimental. Students introduced interfering agents to their experimental ecocolums and predicted the effects on experimental and control conditions and recorded their results.

The comparison condition used traditional instruction from textbook materials and supplemental activities. Instruction included teacher presented material, textbook reading (individual and group), videotapes, discussion, worksheets, and answering questions throughout and at the end of the textbook chapter. Additionally, students observed tadpoles and used art materials to make displays of ecosystems for class and school bulletin boards. Students worked independently the majority of the time; although, some group work was performed.

Dependent measures included a 20-item pre- and posttest on "ecosystems" science content based on information from the textbook and a 10-item performance test to assess conceptual understanding after completion of the unit. The performance test included open-ended questions about ecosystems and required students to draw pictures and diagrams to illustrate understanding of concepts. An elaboration score was calculated by counting the number of words written on the performance test. In addition, a survey of attitudes toward science was administered.

Results showed that students in the treatment group scored higher on the posttest, performance test, and elaboration measure than students in the comparison condition. The five students with disabilities in the treatment group scored at or above the mean score for that group and higher than the mean score in the comparison condition on all dependent measures except the pretest. The authors also reported that students in the treatment condition successfully participated and achieved academically in the general education science classroom when given activity-based instruction.

McCleery and Tindal (1999). In another study, McCleery and Tindal (1999) conducted research in two general education science classrooms and included three groups; Pull Away (PA) included six students (randomly chosen from students who were at risk for failure in the Period A group), Period A included 23 students, and Period B included 28 students. Period A and PA served as the experimental groups, and Period B was the control group. All students received instruction in the conceptual use of the scientific method and conducting a scientific experiment. The same dependent measure was given to all groups and was designed to test proficiency in conducting a scientific experiment and the conceptual use of the scientific method. The outcome measure was scored for inclusion of explanations and richness of explanation in relation to concepts tested.

Period A students met for 90-minute blocks every other day and received instruction in hands-on constructivist activities; students took notes on the problem statement, required equipment, and procedures and were then instructed to collect necessary materials and conduct the teacher-created experiment. When students completed the experiment, they recorded results on a teacher-designed form, cleaned up their equipment, and began their homework assignment if time allowed. The teacher in Period A (a) emphasized concepts and explicit rules, and (b) required students to think about responses, construct individual explanations of findings, and think about how to present and explain their information individually. The teacher in Period A administered the posttest to students in this group.

The PA group received pull-out instruction in a separate, unoccupied classroom five times over a period of six weeks for 40 minutes each session. Pull-out instruction consisted of explicit instruction in scientific concepts including the use of examples and nonexamples, teaching in small steps, guided practice, and successful practice. Students received science instruction with the Period A group when not receiving pull-out instruction, and completed outcome measures with the Period A group.

Period B met for 90 minutes every other day and received the similar instruction in hands-on constructivist activities as the Period A group. Although the Period B group received the same scientific method proficiency measure as Period A and PA, it was administered by a teacher who did not utilize explicit instruction in scientific concepts and offered few teacher-student interactions and little question-and-answer opportunities during the administration of the scientific method proficiency measure. Students constructed a written explanation of their findings on an individual basis and recorded data collected during the experiment.

Results of the outcome measure showed that PA group scores were higher than Period A scores and Period A scores were higher than Period B group scores. Students in the PA group included explanations every time, while those in Period A and Period B groups, provided explanations only some of the time. Furthermore, the PA groups' explanations were superior to those in Periods A and B based on their richness of explanation. Students in Period A were shown to be less actively engaged than the students in the PA group, and students in Period B were not observed for active engagement.

Lynch, Taymans, Watson, Ochsendorf, Pyke, and Szesze (2007). In another study, Lynch et al. (2007) used a quasi-experimental design to examine differences between students with and without disabilities in general education eighth-grade science classrooms. Five middle schools were matched demographically with five additional middle schools and were then randomly assigned to treatment or comparison conditions. Students within treatment and comparison groups were demographically similar. The intervention was a guided-inquiry unit that was student-centered and included hands-on activities from a highly rated science curriculum, Chemistry That Applies (CTA). CTA is designed for students in grades 8 through 10 and takes approximately 6 to 10 weeks for completion. This intervention lasted approximately 6 weeks. Schools in the comparison group used district-approved options, such as traditional textbook instruction, chemistry units, or a combination of materials which did not include the CTA.

Dependent measures included the Conservation of Matter Assessment (COMA) that the students took as a pre-posttest. The COMA includes six selected-response items and four constructed-response items requiring explanations from the students. On the pretest, there was no significant difference between scores of students from the treatment and comparison groups; however, there were significant differences on the pretest within four of the five demographic categories: (a) ethnicity, (b) free and reduced lunch, (c) English for speakers of other languages, and (d) eligibility for special education services. The pretest mean scores for students without disabilities were significantly higher than mean scores for students with disabilities. On the posttest, the mean score for the CTA condition for all students was significantly higher than the mean score for all students in the comparison condition. Effect sizes were in the small to medium range favoring the CTA condition and were significant for all demographic subgroups with the exception of Asian American, where there was no significant difference. In addition, students with disabilities in the CTA condition scored higher on the posttest than students with disabilities in the comparison condition. Results suggest that CTA was as effective for students with disabilities as it was for students without disabilities. Students with disabilities in the treatment condition averaged similar gains from pretest to posttest as students without disabilities in the comparison condition.

Mastropieri, Scruggs, Norland, Berkeley, McDuffie, Tornquist, and Connors (2006). In an additional study Mastropieri, Scruggs, Norland, Berkeley, McDuffie, Tornquist, and Connors (2006) used a randomized field trial design to compare classwide peer tutoring using differentiated instructional activities to teacher-directed instruction. The study occurred across 12 weeks in 13 inclusive eighth-grade science classes where instruction focused on organism reproduction and heredity and genetics. A total of 213 students participated, including 44 students with disabilities. Classroom teachers were matched and then classes were randomly assigned to treatment and control groups. Each lead teacher taught at least one experimental and one control classroom. Instruction in the control group consisted of traditional teacher-directed instruction; activities included teacher lecture, class notes, laboratory-like class activities, and supplementary textbook materials, such as worksheets with fill-in-the-blank, matching, vocabulary, and short-answer items. Students in the experimental group received teacher-directed traditional instruction similar to the control group along with classwide peer tutoring activities. Activities consisted of recall and identification of concepts, facts, and ideas and generation of statements about scientific concepts with illustrations, both with and without prompts. Activities were leveled by difficulty so all students within the general education classroom could participate, regardless of their academic level. All students worked on the same content at their particular level of instruction, and activities were completed as many times as necessary to ensure mastery of the content. Teacher placed students in groups of two or three to complete peer-tutoring activities. Teacher judgement was used to pair higher achieving students with students requiring more assistance. Low-achieving students, including students with and without disabilities, began with the lowest activity level and progressed toward the middle- and high-level activities as proficiency was demonstrated. Students' activity level was determined by teacher judgment of their ability.

Dependent measures consisted of 34-item multiple choice pre-posttests on science content covered during the unit on Scientific Investigation, end-of-year standards-based assessments in science, and an 8-item survey on attitudes towards science and towards instructional activities. Results on the posttest showed a significant effect for peer-tutoring condition (experimental vs. control groups); however, the effects for group (nondisabled students vs. students with disabilities) when compared to the condition were not significant. Survey results showed students with disabilities reported positive attitudes about science. The authors suggested that results supported the effectiveness of using differentiated learning activities with peer partners in middle school science classrooms.

Simpkins, Mastropieri, and Scruggs (2010). In a final study, Simpkins, Mastropieri, and Scruggs (2010) used a crossover experimental design to compare traditional instructional methods with classwide peer tutoring using differential instructional materials in game-based activities. Sixty-one students (43 general education, 15 at risk, and 3 students with LD) in three fifth-grade inclusive science classrooms participated. The intervention occurred one to two times per week for approximately 20 minutes each session and lasted 10 weeks. Instructional units addressed during the duration of the study were: (a) Earth and Space, and (b) Light and Sound.

For the Earth and Space unit, classes one and three received the intervention, and for the Light and Sound unit, they served as the control group. Conversely, class two was assigned to the control condition for unit one, then in turn represented the experimental group for unit two. In the experimental condition, students were trained on peer-tutoring roles as well as activity directions. While both conditions received traditional instruction including teacher lecture, inquiry method experiments, independent practice, science workbooks, video presentation, and interactive science notebooks, students in the experimental condition participated one to two times per week for 20 minutes in differentiated peer tutoring activities. Materials for each science unit were developed in a game-like format including Jeopardy, Motor Cross Raceway, Concentration, Sorry, and Hangman and were included in file folders. Dependent measures included pretests and posttests in production and identification formats, student data sheets on activities, student and teacher surveys, and daily teacher-feedback forms.

Results of the study indicated that class-wide peer tutoring with differential materials resulted in higher gain scores on a production test for students in the experimental group; however, no significant gains were found on the identification test. In addition, typically achieving students outperformed students who were at risk or those with LD. Descriptive data from the dependent variables indicated that the three students with LD experienced positive effects from the intervention. Moreover, teachers and students reported the intervention as enjoyable, interesting, easy to use, and assistive in learning science.

Table 2.1

Summary of Science Intervention Studies for Students with Mild Disabilities

Citation	Subjects	Intervention	Category	Setting	Design	Dependent Measure	Results
Lynch, Taymans, Watson, Ochsendorf, Pyke, & Szesze, 2007	277 students with disabilities, 2,282 total participants	Guided-inquiry unit using student-centered and hands-on activities	Teacher-directed commercial program	8th grade general education science classes	Quasi-experimental Randomly assigned matched pairs to 1 experimental and 1 control group	Conservation of Matter Assessment	Posttest mean scores for the CTA condition significantly higher for all students. Small to medium effect sizes favoring the treatment condition. Students with disabilities in the treatment condition scored higher on the posttest than students with disabilities in the control group.
Mastropieri, Scruggs, Norland, Berkeley, McDuffie, Tornquist, & Connors, 2006	44 total students with disabilities, 7 EBD, 37 LD; 213 total participants	Classwide peer tutoring with differentiated science activities	Peer-assisted	Inclusive 8th grade Science classes	Quasi-experimental Random assignment of class to 1 experiment and 1 control group	Pre-posttest of science content, end of year high-stakes tests in science, survey on attitudes towards science and instructional activities	Posttest results showed significant effect for condition; effects for students with disabilities when compared to students without were not statistically significant.

Table 2.1 continued

(Table 2.1 continued)

Citation	Subjects	Intervention	Category	Setting	Design	Dependent Measure	Results
Mastropieri, Scruggs, Mantzicopoulos, Sturgeon, Goodwin, & Chung, 1998	5 students with disabilities total, 1 EDB, 1 MMR, 2 LD, 1 Multiple disabilities; 75 total participants	Activity-based instruction and inclusion in a general education classroom	Teacher-directed	4th grade elementary school classes	Qualitative/ quasi-experimental with 1 experimental and 1 control group	Pre-posttest of science content, end of unit performance test	Students in treatment group scored higher than students in comparison group. Students with disabilities scored at or above the mean score for treatment group and higher than mean score in comparison group. Students with disabilities successfully participated and achieved academically in the general education classroom.
McCleery & Tindal, 1999	14 students with LD, 57 total participants	Rule-based instruction, hands on activities, explicit-concepts instruction using examples and non-examples	Teacher-directed	6th grade general education Science classes	Quasi-experimental with 2 experimental conditions and 1 control group	Explanations of conceptual use of the scientific method and conducting a scientific experiment	Pull Away group scores higher than Period A scores, Period A scores higher than Period B scores. PA group included explanations every time that were richer than provided by other groups. PA had most active engagement.

Table 2.1 continued

(Table 2.1)

Citation	Subjects	Intervention	Category	Setting	Design	Dependent Measure	Results
McDuffie, Mastropieri, & Scruggs, 2009	62 students with disabilities; 48 with LD and 14 with other mild disabilities, 203 total participants	Peer tutoring utilizing a review of major concepts and vocabulary	Peer-assisted	7^{th} grade general education science classes	Quasi-Experimental Random assignment by class to 1 experimental and 1 control group	Quarter science grades, pre-posttests, end of unit tests, surveys of attitudes towards science, peer tutoring and co-teaching	Students in the experimental group outperformed students in traditional academic instruction on unit tests, but not on cumulative posttest. Specific data analyses comparing students with and students without disabilities not reported.
Simpkins, Mastropieri, & Scruggs, 2010	3 students with LD; 61 typically achieving or at-risk students	Classwide peer tutoring with curriculum materials	Peer-assisted	5^{th} grade general education science classes	Quasi-experimental crossover design; treatment and unit of instruction counter balanced	Pre-posttests on science content, student and teacher surveys	Experimental students scored higher on pre-posttests; typical students outperformed students at-risk or students with LD. Positive effects of treatment for students with LD.

Synthesis of Findings. The current emphasis on the inclusion of students with disabilities in general education science classrooms highlights the need to identify effective academic interventions that can ensure success of students with disabilities in science classes. It seems little is known about effective interventions for students with disabilities in general education science classrooms. Several studies have examined interventions for students with disabilities in clinical or self-contained settings (Bakken, Mastropieri & Scruggs, 1997; Mastropieri, Scruggs, Boon, & Carter, 2001; Mastropieri, Scruggs, McLoone, & Levin, 1985; McCarthy, 2005; Rogevich & Perin, 2008; Scruggs & Mastropieri, 1992; Scruggs, Mastropieri, Bakken, & Brigham, 1993; Smith, Dittmer, & Skinner, 2002), but reveal little about how effective these interventions would be in general education settings. Recent legislation (IDEA, NCLB) requires participation of students with disabilities in general education classrooms to the maximum extent possible and requires students with disabilities to participate in typical standards-based assessments. Therefore the focus of this literature review was to identify research related to interventions completed in general education classrooms. It is important to find intervention research that has been completed in general education classrooms because a majority of students with disabilities are served there. Although research in clinical and self-contained settings may be useful in making decisions about effective interventions in science for students with disabilities, one cannot generalize these findings to general education classrooms. Research is needed to provide evidence that interventions are effective in general education settings before they are recommended for practice.

Limited research has been conducted on interventions for students with disabilities in general education science classrooms. Six empirical studies that implemented various instructional strategies intended to improve the academic outcomes for students with mild disabilities participating in general educational science classrooms were reviewed. The identified studies included a total of 2,891 participants, with 405 students with disabilities in general education science classes, grades four through eight. Two of the six studies were conducted in elementary schools and the remaining four in middle schools. All studies employed a quasi-experimental design, and five of the six used pre- and posttests in science content as dependent measures; the remaining study (McCleery & Tindal, 1999) utilized student explanations of use of the scientific method and conducting scientific experiments.

The interventions implemented in the reviewed studies varied. Three studies included teacher-directed interventions. All teacher-directed interventions included varying degrees of teacher instruction from guided inquiry (Lynch et al., 2007) to explicit rule and concept instruction (McCleery & Tindal, 1999), and also included hands-on activities. Three additional studies included peer-assisted interventions to reinforce learning; two of the peer-tutoring studies used differentiated materials for peer-assisted activities. One study (McDuffie et al., 2009) used peer tutoring in place of traditional warm-up activities to review major concepts and vocabulary. In another peer-tutoring study, Mastropieri and colleagues (2006) substituted hands-on, peer-assisted learning strategies in place of traditional independent workbook practice. The third peer-tutoring study (Simpkins et al., 2010) included peer-assisted learning in game-like activities.

Overall findings demonstrate some effectiveness of (a) peer-assisted learning strategies, (b) instruction in the general education setting with additional pull-out instruction, and (c) activity-based instruction. Peer tutoring has been shown to be an effective tool for students in several academic areas (Stenhoff & Lignugaris, 2007). The findings by McDuffie et al. (2009) demonstrate that students in peer- tutoring groups scored higher on traditional academic end of unit tests in science, but not on cumulative posttests. Specific data analyses comparing students with disabilities to the performance of students without disabilities was not reported. Mastropieri et al. (2006) showed significant improvement for students in the peer-tutoring treatment group compared with teacher-directed instruction on both unit tests and end-of-year, high-stakes tests for students with and without disabilities. Additionally, while students with and without disabilities in the treatment group experienced similar gains on unit tests, significant differences were noted on high-stakes test indicating that typical students outperformed students with disabilities on high-states tests. The final peer-tutoring intervention by Simpkins et al. (2010) also experienced positive results of the peer-tutoring condition; however, gains were found in the treatment condition only on production unit tests and not identification unit tests. Results from the Simpkins et al. (2010) study were similar to those in the Mastropieri et al. (2006) study; general education students outgained students with disabilities. Students with LD receiving the intervention in the Simpkins et al. (2010) study did experience positive effects with effect sizes of .237 for identification tests and .436 for the production test. It is difficult to generalize information about students with disabilities in this study because there were only three participants with LD;

therefore, it is uncertain whether peer tutoring is effective for students with disabilities in inclusive science classrooms. However, results from the three studies indicate that peer-assisted learning in science classrooms appears to be a promising practice for students in grades four through eight. Although research has shown that peer tutoring is an effective intervention for students with disabilities in some academic areas, more research needs to be done on peer tutoring in general education science classrooms to determine whether it is an effective intervention in that specific setting.

Based on limited research found through the literature review, instruction in general education science classes with additional pull-out instruction seems to merit attention for promising practice in improving science outcomes for students with disabilities. McCleery and Tindall (1999) examined the practice of pull-away (PA) instruction from the general education classroom once per week while students continued to work in the general education classroom for the remainder of the time. Students with disabilities who received PA instruction scored higher on academic measures than students with disabilities receiving typical large-group instruction. These findings emphasize the importance of small group, direct, and explicit instruction. However, these study results should be regarded with caution for several reasons. First, only one study examined the effectiveness of pull-out instruction and the study included only four students with disabilities in the PA group, which limits generalizations of the findings. An additional consideration in viewing these results lies with the intervention itself. PA instruction for students with disabilities in a general education science classroom removes them from the inclusive placement and requires additional resources to ensure that PA instruction reinforces instruction provided in the general education setting. The feasibility of PA instruction may limit the use of this model in some situations. Finally, the description of the outcome measure used in this study was unclear. Without specific information about the outcome measure it is difficult to determine the effectiveness of the intervention.

Activity-based instruction emerged as a common theme across the reviewed studies for effective inclusive instruction in science. Four of the studies included activity-based instruction (Lynch et al., 2007; Mastropieri et al., 2006; Mastropieri et al., 1998; McCleery & Tindal, 1999). Mastropieri and her colleagues (1998) found results that clearly established a positive link between academic performance and activity-based instruction. Results from this study highlight the importance of hands-on activities in the science classroom. Students with disabilities who were taught using activity-based instruction scored higher than their non-disabled peers who were taught using traditional textbook instruction. However, all students with disabilities who participated in this study were in the treatment condition, which limits the confidence in the study findings.

A later study by Mastropieri and her colleagues (2006) reported similar findings for activities-based science instruction. Again, students who participated in hands-on activities as opposed to worksheets demonstrated greater gains over students who did not receive peer-assisted hands-on science activities. Students with disabilities experienced similar gains in performance on unit tests, but not on end of year tests, which is a limitation of this study.

In a much larger study, Lynch et al. (2007) found significantly higher mean scores for students with and without disabilities participating in CTA, a commercial science curriculum that used hands-on activities. Mean scores for students with and without disabilities who received CTA were significantly higher than for those students who did not receive CTA. Students with disabilities in the CTA condition scored higher on the posttest than students with disabilities in the comparison condition. This study adds to research that supports the implementation of hands-on activities in the classroom.

McCleery and Tindal (1999) demonstrated that activities-based instruction alone was not as effective as hands-on activities paired with explicit instruction in concept and rules provided in the general education setting or in pull-out support. Results from their study indicated that students receiving pull-out support once per week in addition to hands-on activities experienced greatest gains, followed by those students who received explicit instruction in science concepts in the general education classroom along with hands-on activities. Those students who performed most poorly in this study received only hands-on constructivist activities supporting the need for explicit instruction for not only students with disabilities but also those without.

While limited by number, a synthesis of the reviewed studies seems to support the beneficial nature of including hands-on activities along with teacher-guided, explicit instruction. Results of McCleery and Tindal (1999) reinforce notions that using only constructivist hands-on approaches in inclusive settings may not be effective for students with disabilities. Results from the other four studies indicate that activity-based interventions paired with teacher-directed instructional practices may improve academic outcomes for students with disabilities receiving science instruction in inclusive settings. Few conclusions can be made based upon the limited research that addresses instructional interventions in general education science for students with disabilities; however, collaboration with peers and activity-based instruction seem to be promising interventions for students in general education science classrooms in grades five through eight. Additional research is needed to verify the effectiveness of these interventions and to identify additional effective instructional interventions in general education science classrooms for students with disabilities.

Summary and Conclusions. In sum, this literature review confirms the limited research and highlights the need for additional research on instructional interventions in general education science classrooms for students with disabilities. Only six studies met inclusion criteria for this review. Studies were required to be published in peer-refereed journals, and although conference presentations, book chapters, dissertations, and research available through other venues may provide useful information, publication in refereed journals is one condition that is important when identifying research-based practices. Differences in study participants, setting, location, program type, instruction time, intervention programs and implementation, and outcome measures should be considered when attempting to generalize any of the reviewed results. Therefore, conclusions and implications from this literature review should be interpreted with caution.

Instruction in the general education science curriculum is imperative for all students. For students with disabilities, inclusion in the general education science classroom (a) promotes thinking and problem solving abilities, (b) provides opportunities to participate in the general education setting, (c) provides an introduction into science-related careers, (d) supplies skills for success in college, and (e) provides transition into the life and work of adulthood. The inclusion *and* success of students with disabilities in the general education science classroom is important. The limited findings of this literature review contribute in small part to research on effective instructional interventions for science for the general and special education population, but more research needs to be conducted in this area to ensure students with disabilities can participate and learn in the general education classroom.

CHAPTER THREE

METHOD

The investigation addressed the following questions:

1. What are the effects of a peer-mediated vocabulary intervention in the general education setting on the science achievement of students with and without LD as assessed by quarter numeric grades, slope of improvement on weekly vocabulary matching CBM, a vocabulary measure that assesses term taught throughout the nine weeks, and a seventh grade standards-based assessment?

2. Is the peer-mediated vocabulary intervention differentially effective for students with LD compared to their non-disabled peers?

3. What are the attitudes of students with and without LD toward the peer-mediated vocabulary intervention in the general education science classroom?

4. What are general education science teachers' perceptions of the benefit of the peer-mediated vocabulary intervention for students with and without disabilities in their classes?

Participants and Setting

In this study, 675 seventh-grade students and their eight general education science teachers participated. The study was conducted from January to April. Participants were recruited from two adjacent school districts in the northwestern area of a southeastern state. NAEP data for 2007 for eighth graders in reading and science in this state were lower than the national average. In reading, 31% of students scored below basic, while the national average was 27% below basic. In science, 46% of students scored below basic, while the national average was 43% below basic.

School District One. District One serves over 10,300 students from four-year old kindergarten through twelfth grade. Within this district two middle schools participated in the study. District One employed 991 certified staff members and is the largest employer within the county. Fifty-four percent of students in the district receive free or reduced lunch. District One received a rating of average for Absolute Rating and Growth Rating on their report card for 2009, which means the district performance meets the standards for progress toward the 2010 goal. In addition, 79.6% of their students received a score of basic or higher on the state high-stakes assessment in reading, while 69.2% received a score of basic or higher on the state high-stakes science assessment. District one did not meet Annual Yearly Progress (AYP) goals.

School District Two. District Two serves approximately 16, 500 students from four-year old kindergarten through twelfth grade. Two middle schools within the district participated in the study. Within district two, 42.5% of students receive free or reduced lunch, and 12% of the student population receives special education services. District Two received an Absolute Rating of below average on their report card, meaning they are in jeopardy of not meeting the standards for progress toward the 2010 performance goal. Their Growth Rating was At-Risk and is defined as district performance that fails to meet the standards for progress toward the 2010 performance goal. District Two's performance on this states standards-based assessment in reading was 81.4% scoring basic or higher, and on the high-stakes assessment in science 75% of students scored basic or higher. District Two did not meet AYP goals.

Participation process. Participation in the study involved a multi-step process. First, procedures for protecting participants' rights were approved by the Internal Review Board at Clemson University. Second, consent for participation was obtained from administration within each school district. Third, the researcher met with principals and school administrators at each school to discuss the project and their participation. Information sheets were developed for teachers and administrators to provide a brief description of the study and requirements for participation, without explaining research questions or giving away information about the study (see Appendix A). Once teachers and administrators agreed to participate in the study, the participants and the researcher worked together to determine dates for intervention training, pretesting, implementing the intervention, and posttests. Table 3.1 presents number of classes taught by each teacher and percentages of students' participation per teacher.

Table 3.1

Number of Classes Taught Per Teacher and Participation Percentages

	Number of Classes	Percentage of Participation
Experimental Group		
Teacher 1	6	99%
Teacher 2	6	74%
Teacher 3	3	44%
Teacher 4	5	50%
Total	20	66.7%
Control Group		
Teacher 1	6	65%
Teacher 2	6	99%
Teacher 3	4	54%
Teacher 4	5	92%
Total	21	77.5%
Study Totals	41	72.1%

Teachers. Two seventh-grade science teachers from each of the four participating schools were included in the study, for a total of eight teachers. One teacher from each participating school was randomly assigned to comparison or experimental condition, with one experimental and one comparison teacher at each school. Classes remained intact and teachers in the peer-mediated vocabulary condition implemented the intervention with all classes taught. Random assignment to experimental or control groups by teacher was used to prevent the threat to internal validity by experimenter bias. Demographic information for participating teachers is presented in Table 3.2, and was gathered from a demographic information sheet teachers were asked to complete (Appendix B). Seven female teachers and one male teacher participated in the study. Three teachers held bachelor's degrees; four teachers held master's degrees and one teacher had earned a master's degree plus 30 graduate credit hours. Five participating teachers had degrees in secondary/middle school teaching, 3 in the experimental group and 2 in the control group. Other degrees included 2 bachelor's in elementary education and 1 bachelor's in veterinary sciences. The number of years of science teaching experience ranged from one to 11 years, with a mean of 5 years. The number of years teaching in their present science positions ranged from 1 to 11 years, with a mean number of years at current position of 3.44 years. Teachers were not currently co-teaching any of their classes with a special education teacher. Teachers taught a total of 41 classes, all of which participated in the study.

Table 3.2

Demographic Information for Teacher Participants

	Experimental n=4	Control n=4
Gender		
Male	1	0
Female	3	4
Age Range in Years		
25-30	2	1
31-40	1	1
41-50	1	2
Highest Degree Obtained		
Bachelors	2	1
Masters	2	2
Masters + 30	0	1
Degree Type		
Elementary Education	1	1
Secondary/Middle	1	1
Other	2	2
Total Years Teaching Science	16	24
Mean Years Teaching Science	4.0	6.0
Total Years at Current Position	11	16.5
Total Classes Taught by Group	20	21

Students. Students participated in groups based on the random assignment of their teachers to experimental or comparison groups. Each teacher completed a demographic information sheet (Appendix C) for each student who participated in the study. A total of 675 seventh-grade students participated in the investigation. Fifty-five students, or 8%, had documented LDs according to state criteria for disability classification and were identified as such by their teachers on the student demographic information sheet. This percentage is close to the 2007 national average of students with LD at 5.5% (Cortiella, 2009). Analyses on pretreatment demographic data revealed no significant differences between students in the experimental and control groups. As indicated with chi-square analyses, the groups were comparable on gender, race, free and reduced lunch status, and disability status. Student demographic information is presented in Table 3.3.

Table 3.3

Student Demographics

	Treatment Condition			
	Experimental (n=311)	Control (n=364)		
	% (n)	% (n)	x^2	*p*
Gender			.476	.490
Male	44 (137)	46.7 (170)		
Female	55.9 (174)	53.2 (194)		
Race			5.956	.202
White	78.7 (245)	74.7 (272)		
Black	11 (37)	14.2 (52)		
Hispanic	4 (15)	8.2 (30)		
Asian	1 (5)	1.3 (5)		
Other	2 (9)	1.3 (5)		
Free/Reduced Lunch*			3.463	.063
Yes	38.4 (78)	46.8 (135)		
No	61.5 (125)	53.1 (153)		
Learning Disability			1.763	.184
Yes	9.6 (30)	6.8 (25)		
No	90.4 (281)	93.1 (339)		
Age				
Mean in Months	160.10	160.72		
Range in Months	149-175	149-180		

*One school did not report Free/Reduced Lunch Information—184 values missing

Procedure

After permissions from districts and principals were secured, parent consent and student assent were obtained for all student participants. In addition, teacher participants provided consent and agreed to participate. Teachers were then randomly assigned to either experimental or comparison condition, with one teacher in each group at each school. Experimental teachers were then trained in the intervention and assessment procedures. Control teachers were trained in assessment procedures only. The intervention was implemented over a period of 8 weeks for approximately 35-40 minutes per week. Experimental and control group teachers had equal amounts of time for science instruction and continued on their regular schedules throughout the implementation of the intervention. Experimental teachers implemented the intervention for approximately 10-15 minutes, three days per week, during their regular instructional time; no additional instructional time was given to experimental classes to implement the intervention. Experimental teachers had to be willing to use 10-15 minutes of their regular instructional time three days per week to complete the intervention. Intervention sessions were observed by the researcher and trained graduate students to verify fidelity of implementation of intervention and assessment procedures. All dependent variables are further described in sections that follow.

Data Collection

This study included four dependent variables including (a) pre- and posttest vocabulary term assessment, (b) pre- and posttest seventh-grade science standards-based assessment, (c) second and third quarter numerical science grades, and (d) slope of improvement on vocabulary-matching CBM. Additionally, teacher and student survey data were collected, weekly vocabulary matching quizzes were administered to the experimental group, and science classroom instruction was observed.

Vocabulary term assessment. All participants were administered a vocabulary pretest prior to the intervention (see Appendix D). The pretest consisted of the list of 64 words that were taught over the eight-week period. Each item consisted of a definition and a list of four possible terms, of which one matched the definition. The students entered their answers on a Scantron sheet. Three forms of the test were designed, based on the unit of study completed during the third nine weeks and the eight-week intervention. Students were given the form appropriate to what they were studying during the intervention. Students were administered the same form of the vocabulary assessment pre and posttest. Vocabulary terms were based on the unit of instruction each particular school was studying during the 8 weeks of the intervention.

Seventh-grade science standards-based assessment. The seventh grade science standards-based assessment was designed by the researcher and used multiple-choice questions from a study guide (Triumph Learning, 2005) for this states science standards-based assessment (Hodge & Green, unpublished manuscript). The seventh-grade science standards-based assessment pretest and posttest were administered by the researcher. The assessment consisted of 26 multiple-choice science questions, and students marked their answers on Scantron sheets. Sample questions from the science assessment are presented in Appendix E.

Numerical grades. Numerical 9-week grades were collected for the 9 weeks prior to the intervention, and then again after the intervention had taken place. Although numerical grades can be subjective, they are used often as one indicator of overall performance for students.

Vocabulary-matching CBM. A vocabulary-matching CBM probe was administered prior to, during, and post intervention each week to track the slope of improvement for all students participating in the study. CBM is an assessment system that uses reliable and valid indicators of general outcome measures (Deno, 1985). Vocabulary-matching CBM has emerged as a possibility for assessing student knowledge in the content-areas (Espin & Foegen, 1996; Espin, Shin, & Busch, 2005; Harniss, 2006).

Because vocabulary-matching CBM is a relatively new area of research, the following descriptions are given as a general guideline as to how vocabulary CBM should appear. Students read probes consisting of 22 vocabulary terms, including two distractors, and 20 definitions. A sample vocabulary-matching probe is provided in Appendix F. Terms were randomly chosen with replacement from a master list created from relevant vocabulary chosen from textbooks and curriculum standards. Terms appear on the left side of the page and are arranged alphabetically. Definitions are in one column on the right side of the page and can be modified if necessary so that each has 15 words or fewer. Students are given 5 minutes to read the terms and definitions and to match each term with its definition (Espin & Foegen, 1996; Espin et al., 2005; Harniss, 2006). Students are scored on the correct number of terms and definitions matched in 5 minutes.

Espin and Foegen (1996) studied the general outcome measures of oral reading, maze, and vocabulary matching for predicting performance on content-area tasks. They found that vocabulary matching was the best predictor of content-area reading comprehension as well as acquisition and retention of material. They found reliable and moderately strong correlations between the measure and comprehension questions ($r=.65$), daily test scores ($r=.64$), and the posttest ($r=.62$).

In addition, Espin, Busch, Shin, and Kruschwitz (2001) studied the technical adequacy of vocabulary-matching CBM as an indicator of student performance. They found that the validity of the measures supported their use as indicators of student performance in social studies. In another study, Espin et al. (2005) found that vocabulary-matching CBM probes were a reliable and valid indicator of student progress and that they were sensitive to improvement over time. In this study, the researchers compared the slope of improvement in the experimental group to the slope of improvement in the control group, along with comparing the slope of improvement for students with and without LD. A sample vocabulary-matching CBM probe can be found in Appendix F.

Teacher and student surveys. At the completion of the study, teachers and students in the experimental group completed short surveys to describe their attitudes about the intervention. Surveys were adapted from the Intervention Rating Profile (IRP) by Martens and Witt (1982). The IRP questions were adapted to be more specific to this particular research project. The researcher used the IRP as a guide to write the questions for the teacher and student surveys. The survey took approximately 5 minutes to complete and consisted of 12 questions for teachers and 10 questions for students to answer using a Likert scale rating system. Student and teacher surveys are presented in Appendix G and H respectively.

Science class instruction. Science classes were observed in the experimental and comparison groups for the purposes of describing science instruction. The eight teachers involved in this study followed the academic standards provided by this state for seventh grade science instruction. During the eight weeks of the intervention, teachers concentrated on state standards that focused on students investigating and understanding units of (a) human body systems and life science, (b) chemistry, and (c) cells and heredity. Different schools and districts were working on different units at different times and some units overlapped throughout the 8 weeks. This resulted in three separate sets of vocabulary intervention cards, three sets of intervention quizzes, and three sets of vocabulary assessments.

Classroom instruction followed the proposed scope and sequence of instruction provided by each district. Classroom materials included a seventh grade science textbook and student lab guides that supported the textbooks and the state standards. Materials for instruction in both conditions included (a) PowerPoint presentations and lectures, (b) textbook readings and activities, (c) science videos, (d) worksheets, (e) lab activities, and (f) interactive class activities using a Smartboard or Promethean board. Powerpoint presentations were used to lecture on new material and review previously learned material. Study guides and worksheets reviewed material learned via Powerpoint presentations, textbook readings, videos, and interactive activities. Lab materials were hands on and based on the unit of study during that time. Labs typically included some type of material to be handed in with written conclusions and answers to questions asked throughout the labs. Materials and the sequence in which they were used varied across classrooms and from day to day depending on the content and unit being taught. The researcher or a trained graduate assistant observed in each classroom within the experimental group a minimum of three times across the 8 weeks to verify the fidelity of implementation of the intervention and to provide a general description of instruction. Within the control group, the researcher or a trained graduate assistant observed a minimum of three times across the 8 weeks to provide a general description of typical classroom instruction.

Comparison condition. In comparison classrooms, typical science instruction proceeded as follows. Based on classroom observations, typical lessons began with a warm-up activity, which consisted of a short worksheet, or questions posed on the front board based on materials the students had already learned or questions to make the students think critically about science material. The teachers reviewed their warm-up activity with the class, then reviewed previously learned information from the day before, and typically preview what they would be learning that day. Teachers then presented the new information either via Powerpoint, class lecture, using textbooks, or videos, depending on the material being taught and the unit of study during that time. Students would answer questions posed by the teacher during instruction, take notes during instruction, and complete relevant lab work. Activities varied from day to day depending on the level of complexity of the materials and the unit of study.

Experimental condition. In the peer-mediated vocabulary condition, students received the same types of typical instruction as described in the comparison condition with the exception that three days per week, warm-up activities differed. Rather than completing traditional warm-up activities, students in the peer-mediated vocabulary condition participated the vocabulary intervention with a peer for the first 15 minutes of class twice per week. On a third day, the teachers shortened their warm-up activities to give the short assessments that accompanied the intervention. In summary, two days per week students completed traditional warm-up activities, two days per week students completed the vocabulary intervention with a peer as a replacement activity for traditional warm-up activities, and one day per week students completed intervention assessments with shortened traditional warm-up activities.

Intervention

The following section provides a general description of the science vocabulary intervention, how the intervention was developed, teacher activities during the intervention, and student activities during the intervention, along with student and teacher materials. The intervention lasted 8 weeks and took approximately 35-40 minutes per week to implement in 10-15 minute increments three days per week.

The initial spark that led to the peer-mediated vocabulary intervention came from an article that described literature circles and their roles in science vocabulary (Kucan et al., 2007). The article described one teachers' implementation of literature circles. The teacher gave students roles within the literature circle to discuss targeted science vocabulary terms. As a group, students then completed a literature circle-based vocabulary worksheet, which required students to write definitions, draw pictures, find parts of speech, root words, history/origin, related words, and make connections. The use of a similar strategy in science seemed to be a researchable question. To identify key components critical to vocabulary instruction the researcher examined the National Reading Panel Report (2000) and its findings on vocabulary instruction. According to the National Reading Panel Report (2000), direct instruction of vocabulary can help students learn difficult words, directly taught vocabulary terms related to text students are reading and teaching difficult terms prior to reading can lead to better comprehension, extended instruction promoting active engagement with words promotes word learning, and repeated exposure of vocabulary terms in many context aids learning of vocabulary. With these findings in mind, the researcher designed the current intervention.

The vocabulary intervention began with a whole-class teacher introduction of key vocabulary terms, and students repeated the terms. Each pair of students was provided with a set of eight vocabulary cards (see Appendix I), which were new words related to their unit of study during the 8 weeks and direction cards to refer to the student routine. Students received repeated exposure of key vocabulary terms through reading and listening to their partners read. Through reading and writing definitions, reading the term in sentences provided from the textbook, and reading sentences related to the term, students used key vocabulary terms in context. Additionally, students viewed graphic depictions representing key vocabulary terms and used connections, questions, examples, and additional information to facilitate comprehension and understanding of the key vocabulary terms. Students took weekly vocabulary quizzes over the eight new terms learned for the week. The researcher-developed weekly quizzes consisted of eight items and appeared similar to the vocabulary assessment. Each item consisted of a definition, and a list of four possible terms, one correct term and three distractor terms. See Appendix J for a sample weekly quiz.

Teacher activities and materials. Prior to implementation of the intervention, participating teachers attended a one- to two-hour individual training session. Training session length varied depending on each teacher's questions and understanding of the intervention, its purpose, and procedures. This training session included information on the importance of vocabulary instruction, specifically in the content-areas, the overall project, and their roles in the intervention. Teachers were presented with materials to complete the project including samples of (a) vocabulary intervention cards (Appendix I), (b) student direction cards (Appendix K) (c) vocabulary matching CBM probes (Appendix F), (d) weekly vocabulary quizzes (Appendix J), and (e) a teacher implementation manual (Appendix L) that included a scripted lesson to introduce and practice using the intervention. Teachers were given the opportunity to discuss the implementation of the intervention, ask questions and present concerns they had about implementation of the intervention, with the understanding that the researcher was available to meet with them again if concerns should arise prior to or during the intervention.

Each week, teachers in the experimental condition were asked to introduce eight new vocabulary terms by pronouncing the words for the students and asking the students to repeat the words. The eight vocabulary words were split into two groups, four the first day of the intervention and four the second day of the intervention. The teacher was asked to circulate the room during the intervention to monitor student on-task behaviors and to ensure students were following the steps in the intervention correctly. Once per week, teachers were asked to administer vocabulary-matching CBM probes and weekly vocabulary quizzes. Weekly vocabulary quizzes consisted of the eight new vocabulary terms learned that week. Students were given the definition of the word, and were asked to choose the correct term that matches the definition. Within the comparison classes, teachers were asked to designate five minutes per week to administer vocabulary CBM probes.

The content in the general education science classrooms proceeded according to the typical schedule designed by the teacher and the district. Teachers continued to implement the curriculum for seventh grade science and maintained the instructional pace needed to address the curriculum standards within the required time frame.

Student activities and materials. Prior to the implementation of the intervention, all students were administered a vocabulary assessment consisting of all vocabulary terms that were to be learned over the course of the nine-week period, and a seventh grade science standards assessment. Demographic information was collected for each student for whom permission was obtained. The researcher rank ordered and paired students according to scores on the vocabulary pretest, pairing high achieving with low achieving, as is an accepted practice when using classwide peer tutoring (Harper & Maheady, 2007). The researcher reviewed pairings with the teacher prior to the intervention to receive feedback on possible personality conflicts; teachers were allowed to rematch students who would not work well together, while still considering high and low achievement as a factor in pairing students. No two students with LD were paired together. In each pair, the higher achieving student was assigned the position of Reader 1, and the lower achieving student was assigned the position of Reader 2. Students completed the scripted lesson with the teacher on the first day of the intervention to learn the practices and procedures of the intervention.

Students began the intervention procedures on Day 1 each week by listening to the teacher pronounce each of the four new vocabulary terms for the day and repeating them after he/she reads them. The students then worked together to complete the provided vocabulary cards (Appendix I) using specific sequential procedures, which were provided to the students on the direction cards (Appendix K). The student directions included the following:

1. Reader 1 reads aloud the vocabulary term. Reader 2 reads aloud the vocabulary term.
2. Reader 1 says, "A (vocabulary term) is…(definition)". Reader 2 says, "A (vocabulary term) is…(definition)".
3. Reader 1 reads the sentence from the student textbook that includes the vocabulary term. Reader 2 reads the sentence from the textbook.
4. Reader 1 says, "A (vocabulary term) is categorized as a (scientific tool, scientific process, or scientific concept)". Reader 2 says, "A (vocabulary term) is categorized as a (scientific tool, scientific process, or scientific concept)".

5. Reader 1 and Reader 2 look at the illustration of the vocabulary term and describe together how it illustrates the term. They will say, "This picture shows a (vocabulary term) because (describe how it is illustrated)."
6. Reader 1 reads the Connections, Questions, Examples, and Additional Information and links it to the vocabulary term. Reader 2 describes how the Connections, Questions, Examples, and Additional Information link to the vocabulary term.
7. Reader 1 and Reader 2 work together to write their own definition of the vocabulary term. Each partner must participate.
8. Reader 1 reads the first Related Word and explains how it relates to the vocabulary term. Reader 2 reads the second Related Word and explains how it relates to the vocabulary term. If there are more than 2 Related Words, students will take turns until they have explained the relationship to the vocabulary term for each of them. They will say "(Related word) is related to (vocabulary term) because it (give relationship)."

On Day 2, students reviewed each of the four learned terms from Day 1 of the intervention that week, listened to the teacher pronounce the remaining four new vocabulary terms for that week and repeated them after he/she read the words. They then proceeded with the four new terms in the same manner as on Day 1. On Day 3, students were given five minutes to review the eight terms learned that week with their partner, and were then administered the eight-question weekly vocabulary quiz (Appendix J). Day

3 ended with the five-minute vocabulary matching CBM probe administered by their teacher (Appendix F).

Classroom Observations

Fidelity of implementation checklist (Appendix M) incorporating all elements of the intervention was used by the researcher and trained graduate assistants while observing in the experimental classrooms. Fidelity was measured by dividing the number of behaviors performed correctly by the total number of required behaviors multiplied by 100. Across the eight-week intervention, each teacher in the peer-mediated intervention group was observed a minimum of four times by a researcher or trained graduate assistants. In addition, each teacher in the peer-mediated intervention group was observed at least twice during the assessment portion only of the intervention to ensure assessment procedures were followed correctly. Thus each teacher in the peer-mediated intervention group was observed a minimum of six times throughout the study. Comparison classrooms were observed at minimum twice during the course of the study to provide a general description of classroom instruction.

In the experimental condition, if fidelity of implementation was less than desired, the researcher held a conference with the teacher about the steps in the intervention and how to correct the problem. Fidelity of implementation for the intervention averaged 78% and ranged from 0% to 95%. There was one instance of a 0% fidelity check that was addressed immediately by the researcher in a meeting with that teacher to review intervention procedures and address and correct implementation issues. Following the feedback, the teacher improved fidelity to 75% and subsequent checks were similar to other teachers. Fidelity of implementation for the teacher-administered assessments in the peer-mediated intervention group was 100%.

Interobserver agreement (IOA) was calculated by dividing the number of agreements between the two observers by the total number of agreements and disagreements with the result multiplied by 100. IOA was calculated on 25% of the observations in the experimental condition by summing all the percentages of IOA across sessions and dividing the sum by the number of sessions in which the second observer was present. IOA on the intervention was 97%.

Data Analysis

Research questions one and two require an analysis of differences between groups based on pretest and posttest scores on three of the four dependent variables. A 2 X 2 X 2 repeated measures factorial analysis of variance (ANOVA) was used to examine differences between peer-mediated and non peer-mediated groups and students with and without LD based on the pretest and posttest scores of three dependent variables: (a) vocabulary assessment, (b) seventh-grade science standards-based assessment, and (c) numeric science grades. Repeated-measures ANOVA is commonly used to analyze data when multiple observations are measured on a scale over time (Green & Salkind, 2008). Repeated-measures ANOVA calculates the difference scores, or gain scores, between measures by comparing scores from different levels of the within-subjects factor (Green & Salkind, 2008). Pretest and posttest scores on the vocabulary assessment, science standards-based assessment, and numeric grades were compared using 2 x 2 x 2 factorial repeated-measures ANOVA with within-subjects factors as pretest and posttest scores and between-subjects factors as group (peer-mediated or non peer-mediated) and LD status (students with and students without LD). The design of the study is represented in Table 3.4.

Table 3.4

2x2x2 Repeated-Measures ANOVA Study Design

	Peer Mediated Condition		Non Peer Mediated Condition	
LD	Pretest	Posttest	Pretest	Posttest
Non LD	Pretest	Posttest	Pretest	Posttest

Slope of improvement on the vocabulary-matching CBM measures were calculated for each student using the ordinary least squares method. Slope of improvement scores for peer-mediated and non peer-mediated groups and students with and without disabilities were compared using a one-way analysis of variance (ANOVA) to determine if there were significant differences between groups. Means and standard deviations were calculated for peer-mediated and non peer-mediated groups and students with and without disabilities.

For questions three and four, the mean scores and standard deviations for each question on the surveys were calculated. Means of teacher and student perceptions in the peer-mediated condition were examined to determine their beliefs and attitudes about the intervention and the teacher opinions of the feasibility of the intervention for improving academic outcomes for students with and without LD.

CHAPTER FOUR

RESULTS

The purpose of this study was to evaluate a peer-mediated vocabulary intervention in general education science classrooms for students with and without LD. A number of measures were employed to evaluate the peer-mediated vocabulary intervention and its effectiveness. Students completed a pre intervention assessment on all vocabulary terms to be learned throughout the intervention and seventh grade science standards-based assessment to assess general science content knowledge. Quarter numeric grades, weekly vocabulary-matching CBM probes, pre- and posttest vocabulary, and pre- and posttest science achievement data were analyzed for all students. Teachers participating in the intervention completed a brief questionnaire that assessed their perceptions of the usefulness of the intervention. Students participating in the intervention completed a brief questionnaire assessing their perceptions of the intervention and its usefulness as well.

Results are presented in five parts. First, descriptive statistics are reported for peer-mediated and non peer-mediated groups at pretest for all dependent variables. Second, the effects of the intervention on quarter numerical grades, the vocabulary assessment, science achievement assessment, and slope of improvement on weekly vocabulary matching CBM are provided. Third, results comparing the differential effects of the intervention for students with LD compared to their non-disabled peers are reported. Fourth, descriptive data for teachers' response to the teacher questionnaire are reported. Fifth, descriptive data for students' response to the student questionnaire are reported. Finally, a summary of the research findings is presented.

Research Question 1

What are the effects of a peer-mediated vocabulary intervention in the general education setting on the science achievement of students with and without LD as assessed by quarter numeric grades, slope of improvement on weekly vocabulary matching CBM, a vocabulary measure that assesses term taught throughout the 9 weeks, and a seventh- grade standards-based assessment?

This question was designed to determine the effects of participation in a vocabulary intervention on the science achievement of students in general education science classes. Repeated-measures ANOVA was used to measure the difference between the pretest and the posttest scores for the vocabulary assessments, science standards-based assessments, and quarter numeric science grades. To calculate differences between slopes of improvement scores on CBM measures, ordinary least squares regression was used to determine a numeric slope for each participant. Following the determination of the numeric slope for individual participants, experimental and comparison groups were compared using ANOVA. The following section describes overall results for each dependent variable and compares those results based on experimental and control groups.

Vocabulary assessment scores. A 2 X 2 repeated-measures ANOVA was conducted to determine if the two groups experienced differential change over time on vocabulary scores. The pretest and posttest scores served as the dependent variables, time (pre, post) was the within-subjects factor and group (peer-mediated or non peer-mediated) served as the between-subject factor. This analysis yielded significant main effects for time $F(1, 670) = 101.67$, $p = .000$, eta squared = .131, indicating that the sample as a whole showed improvements on vocabulary scores over the two assessment periods. The between-subject effect approached significance at $F(1, 670) = 1155.31$, $p = .06$. Of most interest to the study, there was a significant two-way interaction between group and pre- and posttest scores $F(1, 670) = 4.150$, $p = .042$, eta squared = .006, indicating that the peer-mediated and non peer-mediated groups experienced differential change on their vocabulary test scores over time.

To interpret the nature of the significant interaction, post hoc analyses were conducted. The sample was stratified by group, and paired t-tests were used to determine if significant change on vocabulary scores occurred for the peer-mediated group only, the non peer-mediated group only, or for both groups but in differing magnitudes. Post hoc analyses using individual t-tests revealed significant differences between pre- and posttest scores at $t(310) = -14.782$, $p = .00$ for mean vocabulary scores of students in the peer-mediated condition as well as significant differences for mean vocabulary scores at $t(363) = -12.187$, $p = .00$ for students in the non peer-mediated condition. Students in both conditions experienced significant growth from pretest to posttest; however, students in the peer-mediated condition experienced growth of 7.45 words over the course of the intervention, while students in the non peer-mediated group experienced growth of only 4.94 words. Table 4.1 presents the means and standard deviations for pretest and posttest scores by group.

Table 4.1

Means and Standard Deviation of Vocabulary Scores by Group

	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD
Peer-Mediated	36.89	12.45	44.34	14.750
Non Peer-Mediated	34.01	13.08	38.95	14.656

Science Assessment Scores. A 2 X 2 repeated-measures ANOVA was conducted to determine if the two groups experienced differential change over time on science scores. The pre- and posttest scores served as dependent variables, time (pretest or posttest) was the within-subjects factor, and group (peer-mediated or non peer-mediated) served as the between-subject factor. This analysis yielded non significant main effects for time $F(1, 670) = .639$, $p = .424$, eta squared = .001, indicating that the sample as a whole did not show improvements on science scores over the two assessment periods. The between subject effect was approaching significance at $F(1, 670) = 156.855$, $p = .053$. Of most interest to the study, there was a significant two-way interaction between group and pre- and posttest scores $F(1, 670) = 4.285$, $p = .039$, eta squared = .006, indicating that the peer-mediated and non peer-mediated groups experienced differential change on their science assessment scores over time.

To interpret the nature of the significant interaction, post hoc analyses were conducted. The sample was stratified by group, and paired t-tests were used to determine if significant change on vocabulary scores occurred for the peer-mediated group only, the control group only, or for both groups but in differing magnitudes. Post hoc analyses with t-tests revealed significant differences at $t(310) = -5.702$, $p = .00$ for mean science scores of students in the peer-mediated condition and no significant differences for mean science scores at $t(363) = .556$, $p = .578$ for students in the non peer-mediated condition. Students in the peer-mediated condition experienced significant growth from pretest to posttest; however, students in the non peer-mediated condition did not. Table 4.2 presents the means and standard deviations for pretest and posttest science scores by group.

Table 4.2

Means and Standard Deviation of Science Scores by Group

	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD
Peer-Mediated	11.22	4.351	12.47	5.197
Non Peer-Mediated	10.63	5.227	10.48	5.847

Quarter numerical grades. A 2 X 2 repeated-measures ANOVA was conducted to determine if the two groups experienced differential change over time on numeric grades. The second and third quarter grades served as the dependent variables, time (second quarter or third quarter) was the within-subjects factor, and group (peer-mediated or non peer-mediated) served as the between-subjects factor. This analysis yielded significant main effects for time $F(1, 654) = 13.046$, $p = .000$, eta squared = .020, indicating that the sample as a whole showed change in numeric grades over the two assessment periods. The between-subjects factor was significant at $F(1, 654) = 3658.031$, $p = .00$. Of most interest to the study, there was a significant two-way interaction between group and numeric grades $F(1, 654) = 5.006$, $p = .026$, eta squared = .008, indicating peer-mediated and non peer-mediated groups experienced differential change on numerical grades over time. However, mean scores for both groups were lower for the grading period following the intervention.

To interpret the nature of the significant interaction, post hoc analyses were conducted. The sample was stratified by group, and paired t-tests were used to determine if significant change on numerical grades occurred for the peer-mediated group only, the non peer-mediated group only, or for both groups but in differing magnitudes. Post hoc analyses with t-tests revealed significant differences at $t(307) = 3.292$, $p = .001$ for mean numeric grades of students in the peer-mediated condition and significant differences for mean numerical grades at $t(349) = 5.649$, $p = .00$ for students in the non peer-mediated condition. Students in both the peer-mediated and non peer-mediated conditions experienced significant change in numerical grades from second to third quarters. Table 4.3 presents the means and standard deviations of numerical grades by group.

Table 4.3

Means and Standard Deviation of Numerical Grades by Group

	Second Quarter Mean	Second Quarter SD	Third Quarter Mean	Third Quarter SD
Peer-Mediated	91.11	7.511	90.19	7.073
Non Peer-Mediated	86.72	9.396	84.83	10.491

Slope of improvement on CBM. The dependent variable, slope of improvement on weekly vocabulary-matching CBM, was analyzed using ordinary least squares regression and resulted in a slope score for each student. Linear analysis is commonly used to estimate growth in CBM progress monitoring data (Fuchs, 2006), and is likely to show true estimates of growth (Christ & Coolang-Chaffin, 2007). The slope score for each student is an estimate of weekly growth across 10 weeks of CBM probes. Overall weekly growth was calculated using the ordinary least squares method and resulted in M

= 0.151, SD = 0.445. A one-sample t-test was used to analyze the mean weekly growth score for all students to determine if overall growth was significantly different from zero. Results of the t-test were significant, t (674) = 8.9, p = .02, indicating the overall slope mean was significantly different from zero. The 95% confidence interval for the slope mean ranged from 0.12 to 0.19. The effect size of 0.34 was calculated by dividing the mean difference by the standard deviation and indicates a small to medium effect size for slope.

ANOVA was used to determine significant differences between groups based on the slope and resulted in non-significance F (1, 674) = 1.119, p = .29. Weekly growth was not different based on peer-mediated or non peer-mediated groups. The means and standard deviations of slope for each group are presented in Table 4.4.

Table 4.4

Means and Standard Deviation of Slope by Group

	M	SD
Peer-Mediated	.171	.459
Non Peer-Mediated	.135	.429

Research Question 2

Is the peer-mediated vocabulary intervention differentially effective for students with learning disabilities compared to their non-disabled peers?

Question two used repeated-measures ANOVA to determine the differences in pretest and posttest scores for vocabulary assessments, science assessments, and quarter numerical science grades and if these gain scores were significantly different based on LD status. Ordinary least squares regression was used to calculate weekly growth scores for all students on vocabulary matching CBM probes, and then ANOVA was used to determine if there were significant differences on slope of improvement between students with and without disabilities.

Vocabulary assessment scores. A 2 X 2 X 2 repeated-measures ANOVA was conducted for group (peer-mediated or non peer-mediated), LD status (students with and students without LD), and time (pretest and posttest scores). Two way interactions between LD status and time were not significant $F(1, 670) = .353$, $p = .552$, eta squared = .001 on vocabulary scores. Students with and without disabilities experienced similar gains when comparing pre- and posttest vocabulary assessment scores. The three-way interaction between group, LD status, and time was not significant $F(1, 670) = .020$, $p = .889$, eta squared = .000 on vocabulary scores. Students with disabilities experienced similar gains in vocabulary assessment scores as students without disabilities, although as previously discussed, there were no significant gains in the non peer-mediated group. No significant differences were evident between group and LD status, which indicates that students in the peer-mediated group with and without LD experienced similar gains, and students in the non peer-mediated group with and without LD experienced similar gains. Table 4.5 presents the means and standard deviations for test scores according to LD status and group.

Table 4.5

Means and Standard Deviation of Vocabulary Gains by LD Status and Group

Measure	LD Status	Group	M	SD
Pretest	LD	Peer-Mediated	25.43	10.002
		Non Peer-Mediated	24.44	9.023
		Total	24.98	9.496
	Not LD	Peer-Mediated	38.12	12.073
		Non Peer-Mediated	34.71	13.064
		Total	36.26	12.729
	Total	Peer-Mediated	36.89	12.455
		Non Peer-Mediated	34.01	13.080
		Total	35.34	12.867
Posttest	LD	Peer-Mediated	32.10	13.563
		Non Peer-Mediated	28.88	10.199
		Total	30.64	12.151
	Not LD	Peer-Mediated	45.65	14.283
		Non Peer-Mediated	39.69	14.672
		Total	42.38	14.787
	Total	Peer-Mediated	44.34	14.750
		Non Peer-Mediated	38.95	14.656
		Total	41.43	14.933

Science assessment scores. A 2 X 2 X 2 repeated-measures ANOVA was conducted for group (peer-mediated or non peer-mediated), LD status (students with and students without LD), and time (pretest and posttest science scores). Two-way interactions between LD status and time were not significant $F(1, 670) = 1.180$, $p = .278$, eta squared = .002 on science scores. Students with and without disabilities experienced similar gains when comparing pre- and posttest science assessment scores. The three-way interaction between group, LD status, and time was not significant $F(1, 670) = .020$, $p = .887$, eta squared = .000 on science scores. Students with disabilities experienced similar gains in science assessment scores as students without disabilities, although as previously discussed, there were no significant gains in the non peer-mediated group. No significant differences were evident between group and LD, indicating that students in the peer-mediated group with and without LD experienced similar gains, and students in the non peer-mediated group with and without LD experienced similar gains. Table 4.6 presents the means and standard deviations for test scores according to LD status and group.

Table 4.6

Means and Standard Deviations of Science Gains by LD Status and Group

Measure	LD Status	Group	M	SD
Pretest	LD	Peer-Mediated	8.13	3.521
		Non Peer-Mediated	7.68	2.594
		Total	7.93	3.114
	Not LD	Peer-Mediated	11.55	4.306
		Non Peer-Mediated	10.85	5.308
		Total	11.16	4.889
	Total	Peer-Mediated	11.22	4.351
		Non Peer-Mediated	10.63	5.227
		Total	10.90	4.849
Posttest	LD	Peer-Mediated	8.67	4.163
		Non Peer-Mediated	6.96	4.168
		Total	7.89	4.215
	Not LD	Peer-Mediated	12.88	5.137
		Non Peer-Mediated	10.74	5.873
		Total	11.71	5.650
	Total	Peer-Mediated	12.47	5.197
		Non Peer-Mediated	10.48	5.847
		Total	11.40	5.642

Quarter numeric grades. Repeated-measures ANOVA was conducted for group (peer-mediated or non peer-mediated), LD status (students with and students without LD), and time (pretest and posttest science scores). Two way interactions between LD status and time were not significant $F(1, 654) = .087$, $p = .768$, eta squared = .00 on numerical grades. Students with and without disabilities experienced similar differences in second and third quarter numeric grades. The three-way interaction between group, LD status, and time was not significant $F(1, 654) = .1.631$, $p = .202$, eta squared = .002 on numeric grades. Students with disabilities experienced similar differences in second and third quarter numeric grades as students without disabilities, although as previously discussed, there were no significant gains for either group. No significant differences were evident between group and LD, indicating that students in the peer-mediated group with and without LD experienced similar differences, and students in the non peer-mediated group with and without LD experienced similar gains. Table 4.7 presents the means and standard deviations for numeric grades according to LD status and group.

Table 4.7

Means and Standard Deviations of Differences in Numerical Grades by LD Status and Group

Measure	LD Status	Group	M	SD
2nd Quarter	LD	Peer-Mediated	83.50	10.207
		Non Peer-Mediated	77.20	8.865
		Total	80.98	10.092
	Not LD	Peer-Mediated	91.93	6.684
		Non Peer-Mediated	87.30	9.125
		Total	89.42	8.417
	Total	Peer-Mediated	91.11	7.511
		Non Peer-Mediated	86.72	9.396
		Total	88.78	8.835
3rd Quarter	LD	Peer-Mediated	83.33	7.689
		Non Peer-Mediated	74.05	9.225
		Total	79.62	9.439
	Not LD	Peer-Mediated	90.93	6.604
		Non Peer-Mediated	85.48	10.214
		Total	87.97	9.155
	Total	Peer-Mediated	90.19	7.073
		Non Peer-Mediated	84.83	10.491
		Total	87.34	9.434

Slope of improvement on CBM. The dependent variable, slope of improvement on weekly vocabulary matching CBM, was analyzed using ordinary least squares regression and resulted in a slope score for each student. The slope score for each student estimates weekly growth across 10 weeks of CBM probes. ANOVA was used to determine significant differences based on the slope dependent variable for LD status and did not show significance, $F(1, 667) = 2.980$, $p = .085$. This indicates weekly growth for students with disabilities was similar to weekly growth for students without disabilities, regardless of group. The means and standard deviations of slope for each group are presented in Table 4.8.

Table 4.8

Means and Standard Deviation of Slope by LD Status

	M	SD
LD	.051	.431
Not LD	.159	.446

An ANOVA was performed to determine if there were significant differences between students with LD and students without LD according to group (peer-mediated or non peer-mediated). The ANOVA did not show significant differences $F(1, 667) = 2.686$, $p = .102$, for group for students with and without disabilities.

Research Question 3

What are the attitudes of students with learning disabilities toward the peer-mediated vocabulary intervention in the general education science classroom?

This question was designed to examine students' attitudes about the science intervention in their general education science classrooms. Students in the peer-mediated condition completed a 10-question researcher-designed survey following the completion of the study. The survey was adapted from the IRP (Martens & Witt,1982). The survey took approximately 5 minutes to complete and consisted of 10 questions the student answered using a Likert scale of one to six, with one as strongly disagree and six as strongly agree,. The mean scores and standard deviations were calculated for each item (see Table 4.9).

Students did not particularly enjoy using the science vocabulary intervention (M=2.80), nor did they report liking the procedures in this intervention (M=2.77), and would not choose to use the vocabulary cards again in their science classrooms (M=2.38). However, students did report that the cards helped them learn important science vocabulary (M=3.83), the cards helped them improve their grades and science achievement (M=3.27), the cards took the right amount of class time (M=3.28), and learning science vocabulary terms was important to them (M=3.39). Students slightly disagreed (M=3.52) that this intervention would help students of any achievement level in their classes. However, the mean score of 4.48 which was the highest rating for all questions indicated that students enjoyed working with a partner on the intervention.

Overall, students reported slightly negative perceptions of the intervention and its ability to help them learn in science (M=3.18).

Table 4.9

Means and Standard Deviations for Student Surveys

Question	M	SD
1. I liked using the science vocabulary cards.	2.80	1.530
2. The vocabulary cards helped me learn important science vocabulary.	3.83	1.470
3. The vocabulary cards helped me improve my grades and science achievement.	3.27	1.590
4. I would like to use the vocabulary cards in my science classes again.	2.38	1.601
5. Using the vocabulary cards took the right amount of time in class each week.	3.28	1.666
6. Learning science vocabulary terms is important to me.	3.39	1.650
7. I liked the procedures used in this intervention.	2.77	1.465
8. I enjoyed working with a partner in my science class.	4.48	1.780
9. This intervention would help students of any achievement level in my class.	3.52	1.538
10. Overall, I liked this intervention and I think it helped me learn in science.	3.18	1.714

Note: n=421*
1=strongly disagree, 2=disagree, 3=slightly disagree, 4=slightly agree, 5=agree, 6=strongly agree

*Throughout the study, teachers removed and disposed of data collected on students for whom parental permission had not been obtained. Teachers failed to do so when administering the student surveys. Survey data was collected anonymously, so it was impossible for the researcher to decipher which surveys were completed by students for whom parental permission to participate had been obtained. Due to the anonymous nature of the survey data, all data were used.

Research Question 4:

What are general education science teachers' perceptions of the benefit of the vocabulary intervention for students with and without disabilities in their classes?

This question was designed to examine teachers' attitudes about the benefit of the vocabulary intervention for students with and without disabilities in their general education science classrooms. All experimental teachers completed a 12-question survey following the completion of the study. The survey was adapted from the IRP by Martens and Witt (1982). The IRP questions were adapted to be more specific to this particular research project. The researcher used the IRP as a guide to write the questions for the teacher survey. The survey took approximately 5 minutes to complete and consisted of 12 questions the teacher answered using a Likert scale of one to six, with one as strongly disagree and six as strongly agree. The means and standard deviations were calculated for each item (see Table 4.10). Overall results of the survey were positive, with the lowest mean score at 4.00, or slightly agree. Teachers indicated the vocabulary intervention would be acceptable for students with and without learning disabilities. Teachers believed that most teachers would find this intervention appropriate for use in a general education classroom, and more specifically that this intervention could prove effective in positively changing a students' science knowledge and achievement. Teachers indicated that they would suggest the use of this intervention to other teachers and they would use this intervention in their classrooms again. Teachers reported the intervention took a reasonable amount of time per week to implement and that the use of the intervention would not result in negative results for the students. In one interesting finding, teachers reported they only slightly agreed (*M*=4.00, *SD*=.000) that this intervention addressed an important deficit in their students' academic knowledge.

Table 4.10

Means and Standard Deviations for Teacher Surveys

Question	M	SD
1. This would be an acceptable intervention for students with learning disabilities.	5.00	.816
2. Most teachers would find this intervention appropriate for use in a general education classroom.	4.75	.500
3. The intervention could prove effective in positively changing students' science knowledge and achievement.	4.75	.500
4. I would suggest the use of this vocabulary intervention to other teachers.	4.75	.957
5. Most teachers would find this intervention suitable for students with and without learning disabilities.	4.75	.957
6. I would use this intervention in my classroom again.	4.25	.957
7. This intervention would NOT result in negative results for the students.	5.50	1.000
8. This intervention would be appropriate for a variety of children.	5.50	.577
9. This intervention addressed an important deficit in my students' academic knowledge.	4.00	.000
10. This intervention takes a reasonable amount of time per week.	5.50	.577
11. I liked the procedures used in this intervention.	4.50	.577
12. Overall, this intervention would be beneficial for the children.	4.50	.577

Note: n=4
1=strongly disagree, 2=disagree, 3=slightly disagree, 4=slightly agree, 5=agree, 6=strongly agree

Summary

The results reported in this chapter describe the nature of a peer-mediated science vocabulary intervention in seventh-grade science classrooms. The results illustrate the variation in science achievement of students with and without LD based on a vocabulary assessment, science standards-based assessment, numerical grades, and slope of improvement on weekly vocabulary matching CBM probes. Results of repeated measures ANOVA revealed that students in the peer-mediated condition experienced higher gain scores for the vocabulary assessment and science standards-based assessment. Results of a t-test for slope of improvement on vocabulary matching CBM report overall weekly growth is significantly different from zero, indicating students did make significant growth on the CBM probes throughout the study. However, results of a univariate ANOVA indicate weekly growth was not significantly different based on peer-mediated and non peer-mediated groups; therefore, conclusions cannot be drawn about the significance of growth based on control and experimental groups. Additionally, repeated measures ANOVA revealed that students with LD experienced similar gains as students without disabilities on the vocabulary assessment, science standards-based assessment, and numerical grades. Univariate ANOVA was used to determine if slope of improvement was significantly different between students with and without LD, and resulted in the conclusion that it was not; therefore, students with LD experienced similar weekly growth as students without disabilities on the slope of improvement CBM measure. Based on their survey responses, students indicated they were not pleased with various facets of the intervention. However, they did indicate they enjoyed working with a partner on the science intervention. Teacher surveys revealed positive reviews of the intervention finding it an important intervention that is effective, efficient, and overall beneficial for all students in their classrooms. A formal discussion of these results and their implications for practice and future research is provided in the chapter that follows.

CHAPTER FIVE

DISCUSSION

Due to provisions of IDEA that require students with disabilities to participate in the general education curriculum to the greatest extent possible, students with LD are served in general education content-area classrooms at increased rates. In addition, NCLB provisions require students with disabilities to participate in statewide content-area standards-based assessments. Although most content-area teachers have content-specific expertise, they are often not prepared to teach students with disabilities and to meet their unique needs in the classroom (Carnegie Council on Advancing Adolescent Literacy, 2010; Scruggs, Mastropieri, & Boon, 1998). Despite the legislative impetus to include students with disabilities, and specifically those with LD, in general education classrooms and statewide assessments, the field has not provided general education teachers with research-based interventions so they may effectively teach students with disabilities in content-area classrooms. Evidence suggests a significant achievement gap for students with disabilities in science (NAEP, 2005). Interventions for students with LD are needed in general education science classrooms so they may learn important science content information and participate successfully in standards-based assessments.

Unfortunately, little research is available on science interventions to address needs of students with LD in general education settings. In fact, a systematic review of literature identified only six studies of science interventions for students with LD implemented in general education science classrooms since 1992. The present study adds to this research base by examining the effects of a peer-assisted science vocabulary intervention in seventh- grade general education science classrooms as measured by a vocabulary assessment, seventh-grade science standards-based assessment, numeric science grades, and slope of improvement on vocabulary matching CBM. Furthermore, it examined teachers' and students' perceptions of and attitudes about the peer-assisted science intervention. Analyses of data revealed interesting and instructive insights into the effectiveness of this science intervention for students with and without disabilities in seventh-grade general education classrooms. Still other findings related to students' perceptions of the intervention were less than favorable and may have been related to the limitations of the study. The remainder of this chapter discusses major findings and their implications for instruction as well as limitations of the study. General conclusions and directions for future research are also described.

Major Findings of the Study

Several major findings from the study are important to consider. First, overall findings from this study indicated that seventh-grade students participating in the science intervention in the experimental condition statistically outperformed students in comparison conditions on two measures: (a) vocabulary assessment, and (b) science standards-based assessment. Findings further indicated significant differences between groups (peer-mediated and non peer-mediated) on numeric grades; however, mean numerical grades decreased from the second nine weeks to the third nine weeks. Second, slope of improvement on vocabulary matching CBM probes for all students who participated in the study indicated meaningful growth across 10 weeks of probes. However, when comparing students in the peer-mediated vocabulary intervention group to students in the control group, there were no differences on weekly growth rates based on group. Third, there were no differences between students with and without LD and their performances on the vocabulary assessment, science standards-based assessment, or numeric grades. In addition, there were no differences between students with and without LD based on group, indicating that students with disabilities experienced similar gains on the dependent measures, regardless of group assignment. Fourth, overall students reported slightly negative perceptions of the peer-assisted science intervention, although they did enjoy working with their peers. Fifth, teachers were generally positive about the peer-assisted science intervention. Two major categories of findings are addressed by each research question: academic achievement findings (research questions one and two) and survey findings (research questions three and four).

Academic achievement findings. Research questions one and two measured the effectiveness of a peer-assisted science vocabulary intervention on academic achievement through three separate repeated-measures ANOVAs for three dependent variables: vocabulary assessment, science standard-based assessment, and numeric science grades. The fourth dependent variable, slope of improvement on vocabulary matching CBM probes, was measured through ordinary least squares regression and univariate ANOVA.

Research question one. What were the effects of a peer tutoring science vocabulary intervention in the general education setting on the science achievement of students with and without LD as assessed by quarter numeric grades, slope of improvement on weekly vocabulary matching CBM, a vocabulary measure that assesses term taught throughout the nine weeks, and a seventh-grade standards-based assessment?

When participating in the peer-mediated science vocabulary intervention, students learned more content than when taught traditionally without peer-mediated science vocabulary intervention on two measures of vocabulary: vocabulary terms taught across the intervention and science standards-based assessment.

Results from the vocabulary assessment and the science standards-based assessment are consistent with previous research that documents the effectiveness of peer-mediated interventions conducted in science classrooms (Mastropieri et al., 2006; McDuffie et al., 2009; Simpkins et al., 2010). Mastropieri et al., (2006) found that the use of classwide peer tutoring combined with differentiated science activities enhanced science content learning for eighth-grade students. In addition, McDuffie et al., (2009) reported that students in the experimental condition who used peer tutoring with a review of major concepts and vocabulary were able to outperform students in the control condition on traditional unit tests in science. Finally, Simpkins et al., (2010) found that students in an experimental condition using classwide peer tutoring with differentiated curriculum materials scored higher than students in the control condition.

An interesting finding related to the vocabulary assessment and the science standards-based assessment on which students in the peer-mediated group outperformed students in the non peer-mediated group is the level of achievement on the assessments. Because students in the peer-mediated group outperformed students in the non peer-mediated group, only results from the peer-mediated group will be discussed here. On both assessments, students in the peer-mediated group performed well below acceptable scoring range. On the vocabulary assessment, scores reported were the number correct definitions matched with the appropriate vocabulary term out of 64 total terms taught throughout the course of the intervention. Students with disabilities had a mean score of 32.10 correct vocabulary matches on the posttest, or 50% correct. Students without disabilities performed somewhat better, with a mean of 45.65 on the posttest or 71% correct, but well below mastery. On the standards-based science assessment, scored reported were the number correct out of 26 total questions that assessed overall science performance on seventh-grade standards. Students with disabilities scored a mean of 8.67 on the posttest or 33% correct. Students without disabilities scored a mean of 12.88 or 50% correct. This information is not reported to detract from the findings of significant growth and differences between peer-mediated and non peer-mediated groups but to highlight the continued need for research-based interventions and strong instruction in middle school science classrooms to improve overall achievement for all students.

Although gains in numeric science grades were significantly different based on peer-mediated and non peer-mediated groups, it is interesting to note that means of grades for both groups were lower in the third nine weeks than in the second nine weeks. One possible explanation for this could be increasingly difficult material throughout the school year. In the third nine weeks, teachers begin intensive preparation for statewide standards-based assessments, and perhaps expectations are raised to better prepare students for assessment. Another explanation for lower grades could be higher expectations for students due to the approaching end of the school year. Teachers are preparing students in seventh grade to be equipped to handle the demands of eighth grade work. Often after the end of the second nine weeks, teachers begin to require more responsibility of the students and expectations are higher. Another possible explanation for lower grades during the third quarter stems from the cumulative effects of failure to master content and vocabulary from previous terms. This explanation seems consistent with the findings related to content mastery on both the vocabulary posttest and the standards-based measure. A final possible explanation for the lower third quarter grades could be that the peer tutoring science intervention distracted students from their studies, took time away from traditional instruction, and resulted in lower mean grades. However, this explanation seems unlikely due to significant improvements in the vocabulary assessments, significant differences by group on science standards-based assessments, and the subjective nature of numeric grades. It seems the students learned in the third nine weeks, although their numeric grades may not have reflected their growth.

Slope of improvement on vocabulary matching CBM has previously been used as a measure to show growth over time and monitor student progress (Christ & Coolong-Chaffin, 2007). CBM was administered across the intervention to determine growth over time based on individual student weekly growth scores. In addition, mean growth rate was calculated for each group to examine differences between groups on weekly growth. Findings indicated that mean growth rate for both peer-mediated and non peer-mediated groups were significantly different from zero; significant growth occurred for both groups across the 8-week study. However, no differences were observed between growth rates for the two groups indicating students in the peer-mediated and non peer-mediated groups experienced similar weekly gains on the vocabulary matching CBM probes.

There are several possible explanations of students' weekly growth for both groups, but no differences between groups. First, although all teachers were trained prior to the study in background, research, and usefulness of CBM teachers did not use CBM to inform instruction throughout the study. Although the primary purpose of CBM is to inform instruction (Deno, 2003), CBM was used only as a means to calculate a measure of weekly growth as a dependent variable in this study. In addition, teachers did not receive feedback on student progress throughout the study due to limited researcher resources for scoring and returning probes. Perhaps because CBM was not used to inform instruction and gain information about student progress, CBM did not carry important meaning to teachers and they did not develop ownership of the assessment.

A second possible lack of differences between groups is the lack of teacher monitoring during the weekly completion of CBM. Because teachers were not trained to use CBM to inform instruction and did not receive feedback on student progress indicated by the CBM probes, they did not develop ownership of the assessment and it did not carry important meaning for them. Had teachers been trained to use CBM data to inform instruction, it is likely that they would have monitored student efforts on the measures. Because training sessions included information about efficacy of research practices, teachers were concerned about making errors in the research process; perhaps they were under the impression they were not to interfere with levels of student effort so the fidelity of the intervention could be maintained.

A final possible explanation of the findings relates to students' lack of interest and investment in the CBM measures. Throughout the study, students' did not receive feedback on the CBM probes or their progress as measured by them. Students did not understand the purpose of the CBM probes, and complained about them to the researcher during classroom observations. Additionally, students wrote negative messages on the probes themselves and students often simply marked answers without careful attention to correct choices. It seems answers on CBM probes were left to chance in many situations, which could impact the findings.

Research question two. Is the vocabulary intervention differentially effective for students with LD compared to their non-disabled peers? Results of analyses on the dependent variables vocabulary assessment, standards-based science assessment, numeric grades, and slope of improvement on vocabulary matching CBM yielded no significant differences between students with and without LD. Although, students in the peer-mediated condition outperformed students in the non peer-mediated condition, students with and without LD in the peer-mediated intervention experienced similar gains on the dependent measures. Similar gains on the dependent measures by students with and without LD suggest the peer-mediated science vocabulary intervention worked comparably well for all students in the experimental condition. Although mean scores indicate students without disabilities outperformed students with LD on the dependent measures, they experienced similar growth throughout the intervention.

These results are similar to previous research conducted on classwide peer tutoring interventions in fifth- and eighth-grade science classrooms. Simpkins et al.,

(2010) reported the use of classwide peer tutoring with differentiated curriculum materials resulted in typically achieving students outperforming students at-risk or students with LD. However, typically achieving students and at-risk or students with LD responded similarly to the experimental treatment. Similarly, Mastropieri et al., (2006) found that classwide peer tutoring with differentiated science activities produced significant effects for condition (experimental or control), but that effects for students with disabilities when compared to students without disabilities were not significantly different.

These results are unusual considering students with LD typically perform poorer than their same-age nondisabled peers (Cortiella, 2009; NAEP, 2005; NLTS-2, 2000). Due to the unique learning characteristics and behaviors of students with LD, one might expect students without disabilities to demonstrate greater gains on dependent measures when participating in an intervention designed to increase academic outcomes. Three potential explanations could contribute to the lack of differences in gains between students with and without LD. First, it is possible that this study was conducted within two school districts that have excellent special education programs and teachers. Students with LD may receive high-quality research-based instruction in their deficit areas, which could contribute to their ability to produce gain scores on the dependent measures equivalent to those gain scores produced by students without disabilities. Another possible explanation for the lack of significant differences in gain scores between students with and without LD is that the majority of students within the school districts where the study was performed are low achieving students. This does not seem to be a plausible explanation in this particular situation considering that in District One 62.2% of the students scored basic or higher on the states science standards-based assessment, and in District Two 75% of students scored basic or higher on the standards-based assessment. However, it is important to remember that scores on the standards-based science assessment represent students who were in seventh grade last school year; they are not scores produced by these particular students. In addition it is important to note that neither district met annual yearly progress goals last year. A final possible explanation for similar gains in students with and without LD is quality of instruction. Though teacher education programs prepare content-area teachers to become experts in their content-area, content-area teachers often lack the instructional skills necessary to teach that content effectively to a range of students (Carnegie Council on Advancing Adolescent Literacy, 2010). It is possible that within participating classrooms, quality of teacher instruction impacted students' achievement gains in science content. This explanation is consistent with the findings related to student mastery of content on the vocabulary posttest and the standards-based assessment. In this study, classroom instruction was observed only to be able to describe instructional techniques, not to evaluate effectiveness of instruction; therefore it is impossible to draw conclusions about teacher effectiveness.

Survey findings. Students and teachers in the peer-mediated vocabulary intervention condition were asked to complete Likert scale type surveys with questions regarding their perceptions and attitudes about the intervention to address research questions three and four. Students and teachers rated questions based on the following scale: 1=strongly disagree, 2=disagree, 3=slightly disagree, 4=slightly agree, 5=agree, 6=strongly agree. Completed surveys were analyzed using descriptive statistics to obtain mean and standard deviation scores for each question within each survey.

Research question three. What are the attitudes of students with and without LD toward the vocabulary intervention in the general education science classroom? First, students' attitudes were overall slightly negative toward the intervention. Students reported they did not like using the science vocabulary intervention, they did not like the procedures used in the intervention, and they would not like to use the vocabulary intervention again. Students slightly disagreed that the vocabulary intervention helped them improve their grades and science achievement; this is noteworthy considering means of numeric grades in science were lower in the third nine weeks than in the second nine weeks. In addition, students slightly disagreed that the intervention took the right amount of class time each week and that the intervention would help students of any achievement level in class.

One interesting finding of the survey was that students slightly disagreed with the statement that learning science vocabulary was important to them. This could be a possible explanation of the mainly negative results on the student survey; if science vocabulary is not important to the students, they are not likely to enjoy and fully participate in a vocabulary intervention that takes place in science classrooms. Additionally, this is a telling statement about students' knowledge of necessary skills to be successful in science. Students in this study were clearly unaware of the importance of vocabulary in concept attainment and comprehension.

Another interesting finding was that students slightly agreed that they enjoyed working with a partner in their science class. This is a promising finding for the efficacy of peer tutoring in middle school science classrooms. Results from this survey are similar to previous research conducted on students' attitudes about peer tutoring in an elementary school setting (Kourea et al., 2007).

Research question four. What are general education science teachers' perceptions of the benefit of the peer-mediated vocabulary intervention for students with and without disabilities in their classes? First, teachers' attitudes perceptions of the benefit of the vocabulary intervention were overall positive. Teachers reported this intervention would help students with disabilities, would not be detrimental to the students' progress, would work for a variety of children, and took a reasonable amount of time per week in their classrooms. Teachers slightly agreed that most teachers would find this intervention appropriate to use in a general education classroom, they liked the procedures used in this intervention, and that this intervention could prove effective in increasing a students' knowledge and achievement in science.

One interesting finding of the survey was that teachers only slightly agreed that this intervention addressed an important deficit in their students' academic knowledge. It is unclear whether teachers are aware of student deficits in content-area vocabulary, or whether they perceive this intervention to be only somewhat effective in addressing the deficit. If teachers' perceptions were related to the inability of the intervention to address students' deficits in academic knowledge, then their perceptions might impact students' attitudes toward the intervention. If teachers do not perceive vocabulary instruction as important, then students may not value the intervention. This is an additional possible explanation of students' negative ratings related to the importance of learning science vocabulary.

Another possibility is that science teachers could be unaware of how important vocabulary instruction in science truly is. Research confirms that vocabulary instruction in science is important due to the technical nature of the vocabulary (Moje & Trayver, 2010, NICHD, 2007) and the strong relationship between vocabulary and reading comprehension and academic success (Boardman et al., 2008; National Reading Panel, 2000; NICHD, 2007). Science teachers' potential lack of awareness of the importance of vocabulary instruction is of concern because the amount of time spent on vocabulary instruction is likely based on the importance they place on the skill.

Limitations

There are several limitations that need to be considered when interpreting these findings. First, only eight teachers in four schools, participated in the study, although the overall sample size of students was acceptable (*n*=675). The small teacher sample makes it difficult to generalize the results beyond this study. As such, studies involving a larger sample of teachers and schools would be helpful. Second, the study was conducted in two different school districts. Although both districts followed the same state standards, order of curriculum varied slightly between the two districts, and in one case between two schools within the same district. Differences in curriculum sequence were accounted for in the intervention and assessments by providing three different sets of vocabulary cards and assessments to the schools whose curriculum sequence varied. Third, these findings should be interpreted cautiously because the unit of interpretation was student rather than teacher. Although teachers were randomly assigned to experimental and control groups, true random assignment of participants was not possible due to their classes being intact groups that could not be changed. Fourth, this intervention was teacher implemented. Although checks for fidelity were implemented regularly, this intervention had not been tested for teacher efficacy prior to this study. There may have been cases where although the teacher was implementing with fidelity according to the checklist, the intervention was not being implemented as intended by the researcher. Fifth, fidelity of implementation data may be skewed due to participants and teachers awareness they were being observed. Finally, this study used researcher-designed measures, and although they were designed and implemented carefully, information about the reliability and validity of these instruments is not available.

Implications for Practice

The findings from this study and other studies (Mastropieri et al., 2006; McDuffie et al., 2009, Simpkins et al., 2010) reveal that middle school students can benefit from peer-mediated interventions in general education science classrooms. More importantly, it suggests that teachers need only implement these interventions for a short period of time in order to see results. Specifically, findings from this study suggest that intensive work on science vocabulary can improve science academic outcome measures. Additionally, findings from this study suggest that teachers can implement peer-mediated science vocabulary interventions. This is an important implication because teachers, not researchers, are in science classrooms on a daily basis. It is important to find interventions that can be implemented in science classrooms by science teachers. Furthermore, these results suggest that the intervention is an effective strategy for all students, with and without LD, and suggests that all students can work together in inclusive classrooms to improve their academic outcomes in science.

However, some enhancements to the intervention may be needed to demonstrate consistent gains and to improve students' attitudes toward the intervention. These results suggest that students may need specific training and practice in peer tutoring conventions. Students may also benefit from the inclusion of an incentive program along with the intervention to increase motivation and effort in learning science vocabulary. These results suggest that teachers could benefit from more systematic and specific training in the use of this intervention and training in CBM, its purpose, and using progress monitoring data to inform their instruction.

Future Research

Although findings from the current study add to the findings from the six studies identified in the literature involving interventions in general education science classrooms for students with disabilities, more research is needed to determine effective interventions that can take place in general education science classrooms. Although the intervention in the current study resulted in positive gains for students, more research is necessary to determine the effectiveness of intensive vocabulary instruction through peer tutoring on academic outcomes in science. A future study could include more training for teachers in intervention procedures, CBM implementation, and an incentive system for students and specific training for students in peer interactions during peer tutoring. In addition, the limitations of this study should be addressed in future studies examining the peer-tutoring vocabulary intervention. Specifically, a randomized control trial with sufficient teachers in each group would provide better evidence of the effectiveness of the intervention.

Although there has been some research conducted in general education classes on science interventions, results remain inconclusive about effective science interventions in general education classrooms. Therefore, additional research examining science interventions that can take place in general education classrooms needs to be conducted. The present study adds to a small group of studies that have been conducted on science interventions in general education classrooms. Future research is needed to examine ways to motivate students to learn science content material and associated vocabulary and the connection of motivation to student outcomes. This would be extremely valuable information for the field of education and might explain why peer tutoring science interventions can be viable instructional options in general education science classrooms.

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APPENDICES

APPENDIX A

TEACHER AND PRINCIPAL SUMMARY SHEET

The Effects of Peer-Mediated Vocabulary Intervention on Science Achievement of Seventh Grade Students With and Without Learning Disabilities

Contact Information:
Julie Green
Dr. Janie Hodge

Project Overview:

- 4 schools, 8 teachers, 1 control and 1 experimental group at each school
- 15 minute intervention, 3 days per week
- 9 week intervention taking place January 12th – March 18th
- prior to intervention 1 hour of pretesting
- after intervention 1 hour of posttesting
- Total Assessment time: approximately 2 hours and 45 minutes

Assessments:

- Vocabulary matching curriculum-based measurement probes—5 minutes per week
- Seventh grade science standards assessment—1 hour total, 30 minutes prior to intervention, 30 minutes post intervention
- Vocabulary Pre/Post Test—1 hour total, 30 minutes pretest, 30 minutes posttest

Teacher Participation:

- **Experimental Group—**
    - Provide the 3rd nine weeks units of instruction to the researcher
    - Approximately 2 hours of training on intervention implementation
    - Complete student and teacher demographic forms
    - Implement the intervention for 15 minutes, 3 days per week
    - Monitor students for on task behaviors and correct students when necessary
    - Administer weekly vocabulary quiz as part of the intervention
    - Administer curriculum-based measurement probes weekly
    - Allow the student researcher and trained graduate assistants access to the classroom for observational purposes
    - Allow time for the student researcher to administer pre and posttests
    - Complete a short survey after the project has been completed
- **Control Group—**
    - Provide the 3rd nine weeks units of instruction to the researcher
    - Complete student and teacher demographic forms

    - Administer curriculum-based measurement probes weekly
    - Allow the student researcher and trained graduate assistants access to the classroom for observational purposes
    - Allow time for the student research to administer pre and posttests

Student Participation:

- **Experimental Group—**
    - Participate in the intervention as part of their regular classroom instruction
    - Complete a weekly vocabulary quiz on words learned that week
    - Complete vocabulary matching curriculum-based measurement probes weekly
    - Complete pre and posttests on science standards and vocabulary knowledge
    - Complete a short survey after the project has been completed
- **Control Group—**
    - Complete vocabulary matching curriculum-based measurement probes weekly
    - Complete pre and posttests on science standards and vocabulary knowledge

Confidentiality:

We will do everything we can to protect the student's privacy. All students will be given an identification number by the researchers. Assessments and test scores will be recorded using the identification number rather than student names. Teachers will distribute and collect materials identified by numbers unique to this study. Materials will be kept in a locked file and will be accessible only to the researchers. Student identities will not be revealed in any publication that might result from this study.

APPENDIX B

TEACHER DEMOGRAPHIC FORM

Name ____

Age: _____ 18-25 _____ 25-30 _____ 31-40 _____41-50 _____51+

Highest Degree:
_____ Bachelor's Degree
_____ Master's Degree
_____ Master's Degree + 30 hours
_____ Doctoral Degree

What degrees have you completed?
_____Elementary Education
_____Secondary Education
_____Special Education
_____Other:
____

How many years have you been teaching science? ______________________

Months/Years at your current teaching position ________________________

How many science classes do you teach? ______________________

What grades?
____

How many total students do you have in each class you teach?
____

How many students with learning disabilities do you teach (per class)?

____

Do you co-teach your science class with a special education teacher? _____yes
______no

How many special education courses have you taken? _______________________

Which course(s) have you taken? (Names and/or description)

Have you had any professional development training in special education? ____yes ____no

If yes, please describe:

APPENDIX C

STUDENT DEMOGRAPHIC FORM

Name ________________________ Date_____________________________

Date of Birth___________________ Teacher_________________________

Student Race___________________ School___________________________

Student Gender__________________ Grade____________________________

Free or Reduced Lunch _____yes _____no

1st and 2nd Nine Weeks Numerical Grade in Science 1st _________ 2nd __________

Does the student have a specific learning disability according to South Carolina eligibility guidelines? _____ yes _____ no

What services does the student receive?

____

How much time and how often does the student receive special education services?

____

Area(s) of LD:
_____ Basic Reading-Decoding and word recognition
_____ Reading Comprehension
_____ Math Computation
_____ Math Problem Solving
_____ Written Expression
_____ Oral Expression
_____ Listening Comprehension

Accommodations Allowed According to IEP? _______ Yes ________ No

Type of Accommodation Provided According to IEP:

_____ Read Aloud ______ Computer Read _____ Extended Time ______ Scribe

APPENDIX D

VOCABULARY TERMS ASSESSMENT SAMPLE

1. Process by which producers and consumers release stored energy from food molecules

    A. gene
    B. locomotion
    C. cellular processes
    D. respiration

2. Something that causes a response in an organism or a part of the body

    A. AIDS
    B. stimulus
    C. chromosome
    D. homeostasis

3. The physical structure in a cell that contains the cell's genetic material

    A. amoeba
    B. circulatory
    C. chromosome
    D. paramecium

4. The brain and spinal cord. Communicates with the rest of the nervous system through electrical signals sent to and from neurons

    A. cellular reproduction
    B. digestive system
    C. function
    D. central nervous system

5. The nucleic acid DNA that is present in all living cells and contains the information needed for a cell's growth, maintenance, and reproduction

    A. AIDS
    B. structure
    C. genetic information
    D. human body systems

APPENDIX E

SAMPLE STANDARDS BASED ASSESSMENT

1. Consider this hypothesis: "The amount of salt in water in a solution will increase the rate at which water will leave the cells of a potato placed in the solution." An experiment to test the hypothesis is summarized in the table.

Experiment to Test the Effect of Salt Water on Potatoes

Group	Surface Area of Potato	Temperature of Water	Time in Water	Percent of Salt in Water
#1	10 cm^2	25°C	6 hours	0%
#2	10 cm^2	25°C	6 hours	10%
#3	10 cm^2	25°C	6 hours	20%
#4	10 cm^2	25°C	6 hours	30%

What is the independent variable in this experiment?

A. temperature of water
B. percent of salt in water
C. surface area of potato
D. rate that water leaves the cells of the potato

2. Which tool can be used only to view dead or preserved cells?
A. magnifying glass
B. compound light microscope
C. dissecting microscope
D. electron microscope

3. Which of the following questions could lead to scientific investigation?
A. How does the acid rain affect plant growth?
B. How can organisms find more attractive mates?
C. How can an organism produce happier offspring?
D. How do a person's beliefs affect eternal life?

4. Why is it important to test one independent variable at a time in a controlled scientific experiment?
A. Any differences between the control group and the experimental group can be linked to the independent variable.
B. Any differences in the controlled variables can be linked to the independent variables.
C. Any differences in the independent variable can be linked to the controlled variables.
D. To prove a hypothesis correct.

APPENDIX F

SAMPLE CBM PROBE

A. aqueous

B. calcium

C. carbohydrate

D. composition

E. constant

F. density

G. depletion

H. hydroelectric power

I. ligaments

J. melting point

K. metals

L. periodic table

M. phenotype

N. precipitate

O. pure substance

P. reproductive system

Q. resources

R. skeletal system

S. soil erosion

T. stomach

U. strep throat

V. tributaries

___1. abundant mineral stored in the bones and teeth where it functions to support their structure

___2. the measure of the relative "heaviness" of objects with a constant volume.

___3. a widely used form of renewable energy produced by falling or flowing water

___4. the temperature range at which a solid changes to a liquid

___5. fibrous bands or sheets of connective tissue linking two or more bones, cartilages, or structures together

___6. made from, with, or by water

___7. element that is malleable, ductile, a good conductor of electricity, and is shiny or metallic

___8. element or compound consisting of only one component with definite physical and chemical properties and definite composition

___9. all the bones in the body that form a framework for shape and support

___10. variable that stays the same during an experiment

___11. use or consumption of a resource, especially a natural resource, faster than it is replenished

___12. nutrient that usually is the body's main source of energy

___13. an arrangement of the elements by increasing atomic number, based on the periodic law

___14. outward physical appearance and behavior of an organism as a result of its genotype

___15. a stream or river flowing into a larger stream or other body of water

___16. a contagious disease caused by infection with streptococcal bacteria

___17. available supplies that can be drawn on when needed

___18. solid that comes back out of its solution because of a chemical reaction or physical change

___19. the manner in which parts are combined or related

___20. a system of organs within an organism which work together for the purpose of reproduction

APPENDIX G

TEACHER SURVEY

The purpose of this survey is to obtain information about the usefulness and practicality of a vocabulary intervention for use in a general education science classroom. Teachers in general education science classrooms who teach students with learning disabilities could use this intervention. Please circle the number that best describes your agreement or disagreement with each statement using the scale below.

1=strongly disagree	2=disagree	3=slightly disagree
4=slightly agree	5=agree	6=strongly agree

1. This would be an acceptable intervention for a child with learning disabilities.	1 2 3 4 5 6
2. Most teachers would find this intervention appropriate for use in a general education classroom.	1 2 3 4 5 6
3. The intervention could prove effective in positively changing a students science knowledge and achievement.	1 2 3 4 5 6
4. I would suggest the use of this vocabulary intervention to other teachers.	1 2 3 4 5 6
5. Most teachers would find this intervention suitable for students with and without learning disabilities.	1 2 3 4 5 6
6. I would use this intervention in my classroom again.	1 2 3 4 5 6
7. This intervention would NOT result in negative results for the students.	1 2 3 4 5 6
8. This intervention would be appropriate for a variety of children.	1 2 3 4 5 6
9. This intervention addressed an important deficit in my students academic knowledge.	1 2 3 4 5 6
10. This intervention takes a reasonable amount of time per week.	1 2 3 4 5 6
11. I liked the procedures used in this intervention.	1 2 3 4 5 6
12. Overall, this intervention would be beneficial for the child.	1 2 3 4 5 6

Adapted from: Martens, B.K. & Witt, J.C. (1982). Intervention Rating Profile.

APPENDIX H

STUDENT SURVEY

The purpose of this survey is to obtain information about the usefulness and practicality of a vocabulary intervention for use in a general education science classroom. Teachers in general education science classrooms who teach students with learning disabilities could use this intervention. Please circle the number that best describes your agreement or disagreement with each statement using the scale below.

1=strongly disagree	2=disagree	3=slightly disagree
4=slightly agree	5=agree	6=strongly agree

1. I liked using the science vocabulary cards.	1 2 3 4 5 6
2. The vocabulary cards helped me learn important science vocabulary.	1 2 3 4 5 6
3. The vocabulary cards helped improve my grades and science achievement.	1 2 3 4 5 6
4. I would like to use the vocabulary cards in my science classes again.	1 2 3 4 5 6
5. Using the vocabulary cards took the right amount of time in class each week.	1 2 3 4 5 6
6. Learning science vocabulary terms is important to me.	1 2 3 4 5 6
7. I liked the procedures used in this intervention.	1 2 3 4 5 6
8. I enjoyed working with a partner in my science class.	1 2 3 4 5 6
9. This intervention would help students of any achievement level in my class.	1 2 3 4 5 6
10. Overall, I liked this intervention and I think it helped me learn in science.	1 2 3 4 5 6

APPENDIX I

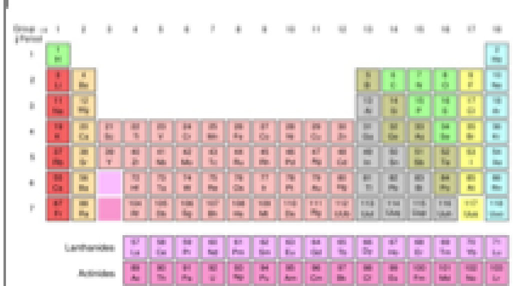
SAMPLE VOCABULARY INTERVENTION CARD

1. **Term:** periodic table
2. **Found Definition:** A table of the elements, arranged by atomic number, that shows the pattern in their properties
3. **Sentence from Textbook:** The periodic table includes a lot of data about the elements and can be used to understand the energy levels (p. 512).

4. Category:
Scientific Tool

6. Connections, Questions, Examples, & Additional Info:
*Atomic number is the same as the number of protons and the number of electrons.
*Atoms are electrically neutral.

5. Illustration:



7. Your Own Definition:

8. Related Words:
Elements
Atomic Number
Electrons
Protons

APPENDIX J

SAMPLE WEEKLY QUIZ

1. An abundant mineral stored in the bones and teeth where it functions to support their structure.

O density
O Vitamin C
O precipitate
O calcium

2. The measure of the relative "heaviness" of objects with a constant volume.

O volume
O constant
O density
O depletion

3. Use or consumption of a resource, especially a natural resource, faster than it is replenished.

O soil erosion
O depletion
O tributary
O precipitate

4. All the bones in the body that form a framework for shape and support.

O reproductive system
O stomach
O skeletal system
O strep throat

5. Nutrient that usually is the body's main source of energy.

O calcium
O carbohydrate
O phenotype
O precipitate

6. Fibrous bands or sheets of connective tissue linking tow or more bones, cartilages, or structures together.

O depletion
O aqueous
O ligaments
O phenotype

7. Available supplies that can be drawn on when needed.

O resources
O tributaries
O ligaments
O metals

8. solid that comes back out of its solution because of a chemical reaction or physical change.

O strep throat
O precipitate
O pure substance
O melting point

APPENDIX K

STUDENT DIRECTION CARDS

Reader 1	Reader 2
1. Read aloud the vocabulary term. 2. SAY: “A (vocabulary term) is (definition)”. 3. Read aloud the sentence from the textbook that includes the vocabulary term. 4. SAY: “A (vocabulary term) is categorized as a (scientific tool, scientific process, or scientific concept)”. 5. Look at the illustration. Describe with your partner how the picture illustrates the term. 6. Read aloud the Connections, Questions, Examples, and Additional Information and work with your partner to discuss how they relate it to the vocabulary term. 7. Work with Reader 2 to write your own definition of the term. 8. Read the 1st Related Word and explain how it relates to the vocabulary term. (If there are more than two, take turns until they have all been read.)	1. Read aloud the vocabulary term. 2. SAY: “A (vocabulary term) is (definition)”. 3. Read aloud the sentence from the textbook that includes the vocabulary term. 4. SAY: “A (vocabulary term) is categorized as a (scientific tool, scientific process, or scientific concept)”. 5. Look at the illustration. Describe you’re your partner how the picture illustrates the term. 6. Discuss with your partner how the Connections, Questions, Examples, and Additional Information relate to the vocabulary term. 7. Work with Reader 1 to write your own definition of the term. 8. Read the 2nd Related Word and explain how it relates to the vocabulary term. (If there are more than two, take turns until they have all been read.)

APPENDIX L

TEACHER IMPLEMENTATION MANUAL

Peer-Assisted Vocabulary Intervention Cards (PAVIC):

A Vocabulary Intervention for 7th Grade Science Classes

A Teacher Implementation Manual

Objectives of This Manual

After studying this manual, you will be able to:

1. Show your students how to prepare their materials for using Peer-Assisted Vocabulary Intervention Cards (PAVIC)

2. Teach students how to use PAVIC

3. Use PAVIC correctly and independently

Benefits

1. Increase student exposure to critical science vocabulary terms

2. Increase student opportunity to say and use critical vocabulary terms

3. Includes tasks that all students can perform successfully

4. Involves all students in the classroom and creates an opportunity for lower achieving students to take a more active role in a valuable classroom activity

5. Provides productive peer interactions and encourages peers' social relationships

How to Use This Manual

This manual was written to provide you with all the information you need to implement the Peer-Assisted Vocabulary Intervention Cards (PAVIC) correctly in your 7th grade science classes. You have been provided with a list of project-related benefits, a timeline, and a detailed overview of PAVIC.

At the completion of the study, you will be given a step-by-step description of the "set-up" procedures—including how to design the intervention cards, pre/posttest design, and how to pair your students.

Training your students in basic PAVIC procedures is very important. You have been provided with a training lesson and script to introduce students to basic PAVIC procedures. The lesson is scripted in words that have been found to be successful in communicating what students must learn. Please follow the script provided to you, but feel comfortable elaborating on any concepts your students do not seem to understand.

A sample vocabulary card for use with the lesson is included in this manual, along with a directions card for each partner, which lists all the verbal statements the students need during each PAVIC session.

Important Dates:

Teacher Training: ____________________

Parent Permission Forms to Go Home:______________________

Pretesting Date:_____________________

Absentee Pretesting Date: ___________________

Intervention Begins: ________________________

Intervention Ends: _________________________

Posttesting Date:___________________________

Absentee Posttesting Date: ___________________

Overview of PAVIC

The intervention will take place in 15-minute increments, three days per week for a total of 45-minutes time per week. The very first session will take approximately 30 minutes: 15 minutes for the introductory lesson in how to use PAVIC, and 15 minutes for "Day One" activities. Each week, students will be given vocabulary cards and a routine to practice vocabulary. On the last day of the intervention each week, students will complete a quiz over the vocabulary learned that week and a curriculum-based measurement (CBM) probe. Teachers can decide which 3 days per week they would like to implement the intervention, however, it should stay the same across the duration of the intervention. The intervention lasts 8 weeks.

Students will get repeated exposure of key vocabulary terms through reading and listening to others read. Through reading and writing definitions, reading the term in sentences from the textbook, and reading sentences related to the term students will use key vocabulary terms. Additionally, students will view graphic depictions representing key vocabulary terms and use connections, questions, examples, and additional information to facilitate comprehension and understanding of the key vocabulary terms.

Each week teachers introduce eight new vocabulary terms by pronouncing the words for the students and asking the students to repeat the words. The teacher will circulate the room during PAVIC to monitor student on-task behaviors and to ensure students are following the steps in the PAVIC correctly. Once per week, teachers will administer weekly vocabulary quizzes and vocabulary-matching CBM probes. Weekly vocabulary quizzes consist of the eight new vocabulary terms learned that week. Students are given the definition of the word, and are asked to choose the correct term that matches the definition. See Appendix A for a sample weekly vocabulary quiz.

Sample Schedule for Intervention:

	Monday	Tuesday	Wednesday	Thursday	Friday
Activity	Introduce New Vocabulary Terms, Students Study 4 New Terms		Introduce New Vocabulary Terms, Students Study 4 New Terms		Students Review 8 Terms for the Week, Take Weekly Vocabulary Quiz, Take 5 minute CBM probe

Intervention days can be scheduled according to teacher preference, however, days should stay the same for the duration of the study.

Procedures for PAVIC

The researcher will rank order and pair students according to scores on the pretest, pairing high achieving with low achieving. The researcher will review pairings with the teacher prior to the intervention to receive feedback on possible personality conflicts. No two students with LD will be paired together. One high achieving student will be assigned the position of Reader 1, the other lower achieving student will be assigned the position of Reader 2. Students will maintain their positions throughout the duration of the intervention. (Teachers will give input on pairs, and students can be rearranged by the researcher if a personality conflict is likely to occur.)

Students will begin the intervention procedures on day one by listening to the teacher pronounce each of the four new vocabulary terms for the day and repeating them after he/she reads them. The students will then work together to complete the provided vocabulary cards using specific sequential procedures. The students will proceed in the following manner:

Student Vocabulary Routine:

1. Reader 1 reads aloud the vocabulary term. Reader 2 reads aloud the vocabulary term.

2. Reader 1 says, "A (vocabulary term) is…(definition)". Reader 2 says, "A (vocabulary term) is…(definition)".

3. Reader 1 reads the sentence from the student textbook that includes the vocabulary term. Reader 2 reads the sentence from the textbook.

4. Reader 1 says, "A (vocabulary term) is categorized as a (scientific tool, scientific process, or scientific concept)". Reader 2 says, "A (vocabulary term) is categorized as a (scientific tool, scientific process, or scientific concept)".

5. Reader 1 and Reader 2 look at the illustration of the vocabulary term and describe together how it illustrates the term. They will say, "This picture shows a (vocabulary term) because (describe how it is illustrated)."

6. Reader 1 reads the Connections, Questions, Examples, and Additional Information and links it to the vocabulary term. Reader 2 describes how the Connections, Questions, Examples, and Additional Information links to the vocabulary term.

7. Reader 1 and Reader 2 work together to write their own definition of the vocabulary term. Each partner must participate.

8. Reader 1 reads the first Related Word and explains how it relates to the vocabulary term. Reader 2 reads the second Related Word and explains how it relates to the vocabulary term. If there are more than 2 Related Words, students will take turns until they have explained the relationship to the vocabulary term for each of them. They will say "(Related word) is related to (vocabulary term) because it (give relationship)."

On day two, students will review each of learned terms from day one, listen to the teacher pronounce each of the four new vocabulary terms for the day and repeat them after he/she reads the words, then proceed with the other new terms for the day in the same manner as on day one. On day three, students will be given five minutes to review all eight terms with their partner, and will then be administered a five-minute weekly vocabulary quiz (which you may choose to use as a weekly grade), and then a five-minute vocabulary matching CBM probe (which may not be used for a weekly grade).

Overview of Each Day's Activities:

Day One—15 minutes
- Teacher read aloud 4 vocabulary terms
- Students follow the Student Vocabulary Routine for each of the 4 new terms using the vocabulary cards

Day Two—15 minutes
- Teacher read aloud 4 vocabulary terms
- Students follow the Student Vocabulary Routine for each of the 4 new terms using the vocabulary cards

Day Three—15 minutes
- 7-8 minute review of all 8 terms for the week
- Students complete weekly vocabulary quiz (2 minutes)
- Students complete Vocabulary-Matching CBM probe (5 minutes only)

Absentees and Uneven Numbers of Students

Throughout the intervention students will be absent from time to time. Here are options for handling students who are absent.

1. If two students are absent, their partners may be paired for the day.

2. Allow a high-performing student to work independently.

3. Form a triad of students who can work together. Within the triad, there will be either two Reader 1's or two Reader 2's, depending on the level of the third student. If he/she is lower achieving assign him/her to be a second Reader 2, if he/she is higher achieving, assign him/her to be a second Reader 1.

Students who are absent can make up missed activities either during class with their partner, or another suitable time during the school day according to the teacher. Students will not take home cards to study independently.

Monitoring Students During Intervention

Careful, daily monitoring by the teacher is crucial to the success of PAVIC. Each session provides you with an opportunity to monitor your students and to provide them with feedback about their implementation of PAVIC and their cooperation with each other. Please circulate continuously during each session, listening to pairs of students working together and correcting behavior as needed.

Introductory Lesson

Teacher Materials:

- Sample vocabulary card (Appendix B)
- Reader 1 and Reader 2 Direction Cards (Appendix C)

Student Materials:

- Sample vocabulary card (Appendix B)
- Reader 1 and Reader 2 Direction Cards (respectively) (Appendix C)

Expected Introductory Lesson Time: 15 minutes

Objectives:

1. Students will be able to perform their respective roles as Reader 1 and Reader 2.
2. Using Direction Cards, students will be able to perform the Student Routines for PAVIC.
3. Students will demonstrate cooperation in writing definitions and throughout the vocabulary learning routine.

Before the Lesson:

1. Put students in pairs as assigned by the researcher.
2. Pass out the sample vocabulary card (Appendix B).
3. Cut apart the Direction Cards (Appendix C) and give to Reader 1 and Reader 2 in each pair.

Lesson Script:

Words written in **BOLD** are what the teacher says. Words written in *Italics* are what the students say or when it's time for them to respond.

Student Lesson for Introduction to PAVIC

TEACHER: **Today we're going to learn a new vocabulary routine to work on our science vocabulary terms. It's called PAVIC. It stands for Peer-Assisted Vocabulary Intervention Cards. In PAVIC you will be paired up with another student in this class—a peer. This person will be your partner. You will work on the PAVIC vocabulary routine together. This routine will help you and your partner gain a better understanding of science vocabulary terms and concepts.**

We will be working on PAVIC for the entire 3rd 9-weeks. You will have the same partner throughout the 8 weeks we are working on this. PAVIC will take place 3 days per week, for 15-minutes a day. In this class, we will work on PAVIC on __(days of the week), ___________, and ___________.

What days of the week will we be working on PAVIC? *wait for response*

In your pairs, you will each have assigned jobs to do. One of you will be Reader 1 and one of you will be Reader 2. You will keep these assignments throughout the 9-weeks.

On each of the days you will be working on PAVIC, you will have specific activities to complete. On Day One each week, I will read aloud 4 vocabulary terms, and using PAVIC and the student routine, you will study the 4 terms.

What will happen on Day One each week? *Wait for correct response*

On Day Two each week, I will read 4 more vocabulary terms and you will use the student routine to study them. So, using PAVIC you will learn a total of 8 new vocabulary terms each week.

How many terms will you learn each week? *Wait for response*

Day Three each week will be a little different. You will be given 7-8 minutes to study the 8 vocabulary terms you have learned that week. How many minutes to study? *Wait for response*

After studying, you will take an approximately 2 minute quiz over the 8 terms you learned that week. This is in multiple choice format and has

only 8 questions. *Tell the students at this time whether or not you plan to use this as a weekly grade.*

How many questions on the weekly vocabulary quiz? *Wait for response*

Finally, you will take a timed Vocabulary-Matching Curriculum Based Measurement Probe that will NOT be graded by me. This CBM probe takes 5-minutes and you will be matching terms to definitions. There are 20 definitions on each probe and 22 terms, so each term will not have a definition. This CBM probe will have terms that you have learned and terms that you have not learned on it. Just do your best and match the ones you know.

I cannot read anything to you or help you in any way on either of these weekly assessments.

Does anyone have any questions about PAVIC so far? *Wait for response*

<u>Student Routine:</u>

TEACHER: **Let's learn the vocabulary routine. Please take a look at the Sample vocabulary card in front of you. Each week you will have 8 smaller versions of these cards given to you and your partner. You will notice that each section on the card is numbered. These numbers match the numbers on the direction cards you have been given. Reader 1 and Reader 2 will take turns to go through the routine. Reader 1 always goes first. Who goes first?** *Reader 1*

Let's look at your sample vocabulary card and your Direction Cards. We will now practice going through the vocabulary routine.

Everyone who is a Reader 1, raise your hand. Everyone who is a Reader 2, raise your hand. Normally you will work in pairs and go at your own pace, but for practice purposes, we are going to go through this as a group, so when I say Reader 1, all Reader 1's will answer. When I say Reader 2, all Reader 2's will answer. Let's begin. Find number 1 on your vocabulary card and on your direction card. Remember, who always goes first? *Reader 1*

We will begin the session with me saying the vocabulary term and you all repeating after me. Ready?

The term is periodic table. What's the term? *Periodic table*

Very good. Normally I would say all 4 terms for today and then you would repeat, but since this is just practice let's begin.

Find your Direction Cards—they will tell you exactly what to do for each number. It's important that each time you do this you say the vocabulary term and follow the directions exactly as they are given on the cards. For number one, both of you in your pairs are supposed to read aloud the vocabulary term. Remember, Reader 1 goes first. Reader 1's read the vocabulary term together. *Periodic table*

Reader 2's read aloud the vocabulary term. *Periodic table*

Very good. Let move on to number 2. Check your direction cards to see what you will do for number 2. Number 2 is the found definition. You will say, "A periodic table is a table of the elements, arranged by atomic number, that shows the pattern in their properties." Let's do it. Reader 1's go first.

Reader 1's: *A periodic table is a table of the elements, arranged by atomic number, that shows the pattern in their properties.*

Good, Reader 2's?

Reader 2's: *A periodic table is a table of the elements, arranged by atomic number, that shows the pattern in their properties.*

Very good. So you can see how each time you do number two you will add in the vocabulary term and the definition to the sentence as you say it aloud.

Let's look at number 3, the sentence from the textbook. Reader 1 will read aloud the sentence from the textbook first. Then Reader 2. Let's do it. Ready?

Reader 1's? *The periodic table includes a lot of data about the elements and can be used to understand the energy levels.*

Reader 2's? *The periodic table includes a lot of data about the elements and can be used to understand the energy levels.*

Let's move on to number 4. In this section you will add the vocabulary term to the sentence and say whichever category the term falls into, which is given to you on the card. Let's try it. Who goes first? *Reader 1*

Good, Reader 1 read what your direction card tells you to say filling in the term and the correct category, given to you on the card. Go. *A periodic table is categorized as a scientific tool.*

Okay, good. Reader 2's? *A periodic table is categorized as a scientific tool.*

Remember, you are NOT just reading what's in the boxes on the vocabulary card, you are using your directions card to help you say it in sentences. It's very important that you follow the directions and go through the routine the way it was written.

Let's look at number 5. What does the direction card tell you to do for number 5? *Look at the illustration. Describe with your partner how the picture illustrates the term.*

Yes, now when it says describe with your partner, does that mean only one person answers? *No*
Right, that means that both partners contribute equally, so you are both going to work on describing the picture. It doesn't have to be anything complicated. It might be something as simple as, "This illustrates a periodic table because it is a picture of one. The elements are shown arranged by atomic number."

Now, turn to your partner, and practice describing the picture and how it illustrates the term.

Does anyone have any questions so far about the routine?

Let's move on to number 6. Reader 1 is going to read aloud the Connections, Questions, Examples, and Additional information. Both partners will discuss how these relate to the given vocabulary term. Let's practice this. Turn to your partners. Reader 1, read aloud from the card. Discuss with your partner how these relate to the vocabulary term we are studying. *Allow time to discuss.*

Good, let's move on. Look at your Direction Card. Number 7 says "Work with your partner to write your own definition." Again, what does work with your partner mean? *Both people contribute to the work.*

That's right, that means that both people will contribute to the work. You will write this definition in your own words. That means you DO NOT copy the given definition, you write it the way you might explain it

to your friend. Let's practice this. Turn to your partners and work together to write a definition for the vocabulary term periodic table, in your own words. *Give time to write.*

Who would like to share with the class the definition of periodic table written in their own words? *Allow one to three pairs to share their definition.*

Great! Okay, Number 8 on the Direction Cards says for each partner to read a related word and explain how it relates to the vocabulary term. Remember, which reader goes first? *Reader 1*

Right. What does the Direction Card say to do if there are more than two related words? *Continue to take turns until they have all been read.*

Very good. Let's practice this. You will say something like this…"Element is related to the periodic table because ____________". Turn to your partner and take turns reading the words related to the vocabulary term and how it relates to the term.

Who would like to share how they linked one of the related words to the vocabulary term? *Allow students to share.*

Excellent. And that's the vocabulary linking routine you will be using with the 8 vocabulary terms each week. Obviously, this practice took a lot longer than it will when you are doing the "real" cards with your partner. Remember, how much time per day do you have to use PAVIC? *15 minutes* **That's right, 15-minutes. And how many words do you have to do per day?** *4 words* **Yes, 4 words, that means that you will have about 3 minutes per card each day that you use PAVIC. You will need to move quickly through this routine and with purpose. What does working with purpose mean?** *Trying to get things done; or another suitable answer.* **Yes, working with purpose means you are trying to get things done. You do not have to rush, but you also do not have time to play around.**

Does anyone have any questions about the routine?

Let's review.

How many days per week will you use PAVIC? *Three days per week*

What are your activities for Day One each week of PAVIC? *The teacher will read aloud 4 new vocabulary terms, then we will go through the vocabulary routine using the PAVIC for each of the 4 terms*

What are the activities for Day Two each week? *The teacher will read aloud 4 new vocabulary terms, then we will go through the vocabulary routine using the PAVIC for each of the 4 terms*

How many words per week are you learning with PAVIC? *8 words*

What are the activities on Day Three of PAVIC? *First we will study all 8 words learned for the week, then take a weekly vocabulary quiz, then take a Vocabulary-Matching CBM probe*

How much time will you get to study? *7-8 minutes*

What is the weekly quiz over? How many questions will it have? *It will cover the 8 new words you learned that week. It will have 8 multiple choice questions.*

How long does the CBM probe take? What will you have to do to complete it?
We can have only 5 minutes to complete it. It's timed. We will match terms to defintions.

Are you going to know all of the terms on the CBM probes? Is it okay if you don't?
There will be some we know and some we don't. It's okay if we don't know them all.

Very good. Are there any other questions???
Good. Let's get started with PAVIC!

<u>Directions to Administer the Weekly Vocabulary Quiz</u>

Each week I will deliver the 8 question weekly vocabulary quiz to you. This quiz is not timed, but should only take a minute or two to complete. Please have students bubble their choice of the correct vocabulary term to match the definition they are given for each question. Please collect these and put them back into the manilla envelope they were delivered in for pick up by a researcher.

Standardized Directions to Administer the Vocabulary-Matching CBM Probe

Each week I will deliver the CBM probes to you. The CBM probe has standardized directions you will see below. Please read these directions word for word everytime you administer the probe to your students. The students only get 5 minutes to complete the CBM probe. When the timer goes off, students must put down their pencils and turn in their papers. Please put the CBM probes back in the manilla envelope they were delivered in for pick up by a researcher.

Please say:

This is a Vocabulary-Matching CBM probe. There are 20 definitions, and 22 vocabulary terms you will match with the definitions. There are 2 extra terms, so when completed you will have 2 that cannot be matched with a definition. I cannot read anything on this probe to you or help you in anyway. You may not know all of the terms given on the probe, but please do the best you can with the ones you do know. Clemson University is using this probe to monitor your progress in science.

You will have 5 minutes to complete this Vocabulary-Matching CBM probe. You may start the probe when I say begin. When the timer goes off please put down your pencils and turn in your papers. Please do NOT work after the timer has buzzed. Does anyone have any questions?

You may begin.

(TEACHER MANUAL APPENDIX A)
Sample Weekly Quiz

1. An abundant mineral stored in the bones and teeth where it functions to support their structure.

   O density
   O Vitamin C
   O precipitate
   O calcium

2. The measure of the relative "heaviness" of objects with a constant volume.

   O volume
   O constant
   O density
   O depletion

3. Use or consumption of a resource, especially a natural resource, faster than it is replenished.

   O soil erosion
   O depletion
   O tributary
   O precipitate

4. All the bones in the body that form a framework for shape and support.

   O reproductive system
   O stomach
   O skeletal system
   O strep throat

5. Nutrient that usually is the body's main source of energy.

   O calcium
   O carbohydrate
   O phenotype
   O precipitate

6. Fibrous bands or sheets of connective tissue linking tow or more bones, cartilages, or structures together.

   O depletion
   O aqueous
   O ligaments
   O phenotype

7. Available supplies that can be drawn on when needed.

   O resources
   O tributaries
   O ligaments
   O metals

8. solid that comes back out of its solution because of a chemical reaction or physical change.

   O strep throat
   O precipitate
   O pure substance
   O melting point

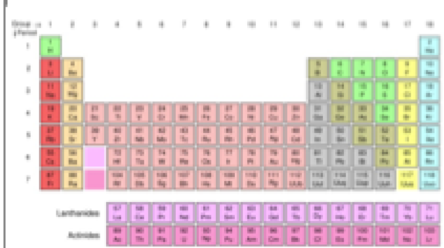
(TEACHER MANUAL APPENDIX B)

1. **Term:** **periodic table**
2. **Found Definition:** **A table of the elements, arranged by atomic number, that shows the pattern in their properties**
3. **Sentence from Textbook:** **The periodic table includes a lot of data about the elements and can be used to understand the energy levels (p. 512).**

4. Category:
Scientific Tool

6. Connections, Questions, Examples, & Additional Info:
*Atomic number is the same as the number of protons and the number of electrons.
*Atoms are electrically neutral.

5. Illustration:



7. Your Own Definition:

8. Related Words:
Elements
Atomic Number
Electrons
Protons

(TEACHER MANUAL APPENDIX C)

Reader 1	Reader 2
1. Read aloud the vocabulary term. 2. SAY: "A (vocabulary term) is (definition)". 3. Read aloud the sentence from the textbook that includes the vocabulary term. 4. SAY: "A (vocabulary term) is categorized as a (scientific tool, scientific process, or scientific concept)". 5. Look at the illustration. Describe with your partner how the picture illustrates the term. 6. Read aloud the Connections, Questions, Examples, and Additional Information and work with your partner to discuss how they relate it to the vocabulary term. 7. Work with Reader 2 to write your own definition of the term. 8. Read the 1st Related Word and explain how it relates to the vocabulary term. (If there are more than two, take turns until they have all been read.)	1. Read aloud thevocabulary term. 2. SAY: "A (vocabulary term) is (definition)". 3. Read aloud the sentence from the textbook that includes the vocabulary term. 4. SAY: "A (vocabulary term) is categorized as a (scientific tool, scientific process, or scientific concept)". 5. Look at the illustration. Describe you're your partner how the picture illustrates the term. 6. Discuss with your partner how the Connections, Questions, Examples, and Additional Information relate to the vocabulary term. 7. Work with Reader 1 to write your own definition of the term. 8. Read the 2nd Related Word and explain how it relates to the vocabulary term. (If there are more than two, take turns until they have all been read.)

APPENDIX M

IMPLEMENTATION FIDELITY CHECKLIST

Science Vocabulary Intervention
Fidelity Check Form

Name of Observer:_________________________ Date:________________________

School:______________________ Teacher: ___________________________________

Class:_____________Start Time:___________________ Stop Time:_______________

Is this an assessment day? ___Yes___No If yes, go to Section III.

I. Introduction to Intervention:

Did teacher read aloud 4 vocabulary terms? ___Yes ___No

Did the class repeat the 4 vocabulary terms? ___Yes ___No

II. Intervention (Student Routine):

Please discreetly observe a pair of students performing the routine. Try not to observe the same students again on subsequent observations. A checkmark by "Yes" indicates this step was completed as described. A checkmark of "No" indicates it was not completed as described. For any "No" checkmarks, please elaborate specifically what occurred in the comments section.

1. Reader 1 reads aloud the vocabulary term. ___Yes ___No
   Reader 2 reads aloud the vocabulary term. ___Yes ___No

2. Reader 1 says, "A (vocabulary term) is…(definition)". ___Yes ___No
   Reader 2 says, "A (vocabulary term) is…(definition)". ___Yes ___No

3. Reader 1 reads the sentence from the student textbook that includes the vocabulary term. ___Yes ___No
   Reader 2 reads the sentence from the textbook. ___Yes ___No

4. Reader 1 says, "A (vocabulary term) is categorized as a (scientific tool, scientific process, or scientific concept)". ___Yes ___No
   Reader 2 says, "A (vocabulary term) is categorized as a (scientific tool, scientific process, or scientific concept)". ___Yes ___No

5. Reader 1 and Reader 2 look at the illustration of the vocabulary term and describe together how it illustrates the term. They will say, "This picture shows a (vocabulary term) because (describe how it is illustrated)." ___Yes ___No
   Did BOTH students participate? ___Yes ___No

6. Reader 1 reads the Connections, Questions, Examples, and Additional Information and links it to the vocabulary term. ___Yes ___No
   Reader 2 describes how the Connections, Questions, Examples, and Additional Information links to the vocabulary term.___Yes ___No

7. Reader 1 and Reader 2 work together to write their own definition of the vocabulary term. .
   Did the students work together? ___Yes ___No

8. Reader 1 reads the first Related Word and explains how it relates to the vocabulary term. They will say "(Related word) is related to (vocabulary term) because it (give relationship)."
   ___Yes ___No
   Reader 2 reads the second Related Word and explains how it relates to the vocabulary term.They will say "(Related word) is related to (vocabulary term) because it (give relationship)."
   ___Yes ___No
   If there are more than 2 Related Words, students will take turns until they have explained the relationship to the vocabulary term for each of them.
   Were there more than 2 Related Words? ___Yes ___No
   Did the students work together? ___Yes ___No

9. Did the teacher monitor and provide assistance during the partner activity?
   ___Yes ___No

III. Assessments:

Did the teacher administer the Weekly Vocabulary Quiz? ___Yes ___No

Did the teacher administer the CBM probe? ___Yes ___No

Did the teacher read the standardized directions for the CBM probe?
___Yes ___No

Did the teacher accurately time the probe for **5 minutes** after saying the word begin?
___Yes ___No If no, how long was allowed?_____________
Did the students' pencils go down when the timer went off?___Yes ___No

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Comments: