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The effects of interactive word walls on students with learning disabilities in the secondary science classroom

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THE EFFECTS OF INTERACTIVE WORD WALLS ON STUDENTS WITH LEARNING DISABILITIES IN THE SECONDARY SCIENCE CLASSROOM

By

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Abstract

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THE EFFECTS OF INTERACTIVE WORD WALLS ON STUDENTS WITH LEARNING DISABILITIES IN THE SECONDARY SCIENCE CLASSROOM
2015-2016
Amy Accardo, EdD
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Effective approaches for teaching vocabulary to various populations of learners is a topic of current research (Barr, Eslami, & Malatesha, 2012) yet little research is dedicated to students with learning disabilities in the science classroom. Within this study the interactive word wall was used as a tool to build vocabulary and to encourage usage of new subject-specific terminology. The experiment utilized quasi-experimental pre-post test comparison group design using interrupted time-series (Johnson & Christiensen, 2007) due to the inability to randomize participants and establish a clear control group. The data was collected across four units of terminology and with a student satisfaction survey. Students reported at least seventy percent satisfaction with the use of Interactive Word Walls and demonstrated some performance increase in both vocabulary retention and reading comprehension when utilizing Interactive Word Walls.

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Chapter 1

Introduction

Explicit vocabulary instruction is intensive in the primary grades and gradually becomes integrated into other forms of instruction as content gets more challenging (Hooper, 2015). Learners with strong reading comprehension are often able to use context clues and naturally develop their vocabulary, despite the lack of explicit instruction at the secondary level (Bryant, 2003). Unlike higher level learners, some students with learning disabilities struggle with developing their vocabulary without explicit instruction (Bryant, 2003). When content area teachers do present vocabulary it is often a few key words that have little personal significance, making it difficult for students to retain the words or connect them to their lives (Carr, 1985).

Previous research indicates that there is a strong relationship between word knowledge and academic success (Jackson, 2011). Developing word knowledge in content areas will increase the success of the student in that particular area as well as support cross-content connections (Fazio & Gallagher, 2013). It is necessary for teachers to provide the opportunity for students to explicitly work on developing this word knowledge but it is often an instructional method that is removed from the classroom early (Jackson, 2011). Teachers providing science instruction, in particular, tend to shy away from explicit vocabulary instruction prematurely and instead place emphasis on hands-on experimentation and active participation (Fazio & Gallagher, 2013). This emphasis does not mean that one should minimize the importance of language and reading comprehension since current science education reforms promote science literacy (Cohen & Johnsen, 2012). The Next Generation Science Standards (2013) are the new accepted standards for many states and they emphasize a change from remembering information to preparing students to participate in inquiry-based learning. Science vocabulary not only includes content specific terminology, but incorporates general academic terms that can be considered cross-content such as *analyze* or s*ignificant* (Hooper & Harmon 2015). Familiarizing students with these terms not only improves their abilities in the science classroom, but can increase their academic success in other areas. It is imperative that teachers identify new and productive ways to dedicate a portion of classroom time to vocabulary instruction to increase word knowledge and improve academic success of students.

Statement of Problem

For a variety of reasons, some students are entering high school without the literacy skills required for academic success and future preparation (Alvermann, 2001; Grosso de Leon, 2002). One suggested reason is that the pressure of high stakes testing in the areas of reading and math in elementary schools in the United States has reduced the amount of time teachers have to spend on content area subjects, such as science, in the early years of education (Cohen & Johnsen, 2012). Students enter secondary school with limited science knowledge and are expected to have a certain subject area understanding that they are often lacking due to the inadequate exposure they are now getting in the primary grades (Cohen & Johnsen, 2012).

Students with learning disabilities are often behind their typical peers because of limited vocabulary and difficulty navigating content-specific text (Helman, Calhoun, & Lern, 2015). Since students with learning disabilities tend to avoid reading and struggle with extracting word meaning from context it is imperative that teachers implement direct vocabulary instruction (Beach, Sanchez, Flynn, & O'Connor, 2015). Beach and colleagues report that despite evidence to support direct vocabulary instruction, content-specific instructors rarely utilize this method and students are exposed to science content words in the secondary classroom at a high rate with little time spent on explicit instruction of these words (2015). Explicit language instruction requires time that many teachers already have difficulty finding due to the rigor of the curriculum and material that must be covered by the conclusion of the academic year. In order to ensure the students are exposed to the 'required' material the information is oftentimes presented quickly and in context with the hope that exposure alone will encourage students to improve their vocabulary content knowledge (Fazio & Gallagher, 2013). Research indicates that extending adolescents' vocabulary knowledge through direct and explicit vocabulary instruction is a worthwhile endeavor for all subject area teachers, including teachers of struggling readers and students with learning disabilities (Beach et al., 2015). It is necessary to find methods that allow for explicit instruction, consistent/repeated exposure, and student input (Fazio & Gallagher, 2013). These methods should visually and contextually allow adolescent students the opportunity to connect introduced vocabulary to images and familiar terms (Fazio & Gallagher, 2013).

Significance of the Study

By conducting this study and comparing vocabulary retention and reading comprehension before and after introducing the use of word walls, the effect of integrated vocabulary instruction will be evaluated. According to research, academic vocabulary knowledge impacts students' access to subject-area content and predicts their overall academic achievement within these subjects (Beach et al. 2015). Identifying effective vocabulary enrichment strategies that can be incorporated into daily content courses may provide teachers the opportunity to potentially improve student content understanding and confidence. Visually organizing information using interactive word walls will allow students to identify important words and ideas while linking those ideas to one another (Heinrichs, 2012).

As many schools and states are relying more and more on standardized tests and end of course exams, it is imperative that children are prepared and familiar with as much subject-specific vocabulary as possible. Beach et al. (2015) suggests that providing students (especially students with learning disabilities) the opportunity to write using the newly introduced vocabulary can improve both their comprehension and retention of the terminology. Exposing students to the vocabulary and incorporating writing with the newly introduced words through interactive word walls builds on this research recommendation and may provide educators with an interactive and creative way to expose and practice the use of vocabulary (Fisher & Blachowicz, 2013).

Purpose of the Study

Effective approaches for teaching vocabulary to various populations of learners is a topic of current research (Barr et al., 2012) yet little research is dedicated to students with learning disabilities in the science classroom. For years word walls have been used to provide examples of commonly misspelled words, to encourage word analysis, and to build vocabulary (Brabham & Villaume, 2001). Traditionally word walls are a collection of words in a specified area that students may be exposed to throughout their studies and this wall may remind them of words and how to spell them. (Jackson et al. 2011) Additionally, much research attention has been awarded to the use of word walls in the primary and middle school age groups but little has been devoted to the use of word walls within a secondary classroom (Heinrichs & Jackson 2012; Hooper & Harmon 2015; Jackson, Tripp, & Cox, 2011).

Within this study the interactive word wall was used as a tool to build vocabulary and to encourage usage of new subject-specific terminology. An interactive word wall is different than a traditional word wall because it acts more like a semantic map, or a graphic organizer that the entire class is exposed to (Jackson et al. 2011). It is hypothesized that increasing the interaction with the words will increase the students' familiarity with the terms and thus improve vocabulary retention and related reading comprehension. At the conclusion of this study the effectiveness of the use of interactive word walls within the secondary science classroom by students with learning disabilities will be assessed.

Along with determining the impact of interactive word walls in terms of vocabulary acquisition and reading comprehension, satisfaction surveys will determine if the method is one that adolescent students with learning disabilities are content with as an instructional method. Participants will be asked to consider their preferred method of vocabulary instruction, comparing instruction with or without word walls. Having both academic data and student social response information available will provide insight into whether interactive word walls are an effective form of explicit vocabulary instruction, and whether adolescent students perceive instruction using interactive word walls as valid.

Research Questions

1. Will the use of interactive word walls in the science classroom impact the vocabulary retention of students with learning disabilities?
2. Will the use of interactive word walls in the science classroom impact the reading comprehension of students with learning disabilities?
3. Are secondary students with learning disabilities satisfied with the use of interactive word walls to foster vocabulary retention and reading comprehension in the science classroom?

Key Terms

-*Interactive Word Walls* defined as collections of developmentally appropriate vocabulary displayed somewhere in a classroom (Brabham and Villaume 2001; Thompkins 2003; Vallejo 2006) that require students actively participate by generating visual connects to place on the wall.

-*Comprehension* defined as the ability to read and understand the object of the material being presented.

-*Vocabulary Acquisition* defined as the ability to identify meaning and relation of new terminology.

-*Vocabulary Retention* defined as the ability to maintain understanding of new terminology long-term

Chapter 2

Review of Literature

While there has been significant research done to determine the effectiveness of word walls at the elementary level, there is little research related to using them within a secondary classroom (Heinrichs & Jackson 2012; Hooper & Harmon 2015; Jackson et al. 2011). According to research conducted by Hong and Diamond (2011), a combination of explicit and responsive instruction can increase student vocabulary knowledge better than either instructional method independently. Findings from their study of over 100 early childhood students provided with a combination of responsive and explicit instruction showed their vocabulary knowledge increased significantly compared to responsive teaching alone (Hong & Diamond, 2011). Interactive word walls combine multiple instructional strategies and create a print-rich environment for learning while encouraging students to use the terms regularly throughout their instructional period and beyond (Jackson et al. 2011; Brahbam, 2001).

Research into the effectiveness of using word walls within the primary classrooms with typical students has determined it to be a useful teaching method, but little research has been conducted to determine the efficacy on students with learning disabilities (Jackson et al. 2011; Heinrichs & Jackson 2012; Hooper & Harmon, 2015). Students with learning disabilities tend to be less proficient in word learning strategies which results in fragmented and less complete knowledge of words (Jitendra, Edwards, Sacks, & Jacobson, 2004). Identifying instructional strategies to assist students with learning disabilities in increasing their content-specific vocabulary may positively impact reading comprehension. An emphasis on vocabulary instruction for students with learning disabilities can improve performance within the science classroom (Seifert & Espin, 2012). Building academic content vocabulary is an important part of science instruction (Jackson et al, 2011) and may ensure that students are able to understand the information presented to them.

This study aims to determine if there is a relationship between the use of interactive word walls, vocabulary retention, and reading comprehension of students with learning disabilities in the science classroom. Previous research indicates that explicit vocabulary instruction is deemphasized as content requirements increase (Jitendra et al., 2004). Integrating explicit vocabulary instruction through interactive word walls in the science classroom may increase student vocabulary retention and reading comprehension.

Vocabulary Instruction

While research is consistently providing data to support new and evolving methods of teaching vocabulary there are general guidelines that are agreed upon throughout the literature (Jitendra et al. 2004) when working to improve student vocabulary. The guidelines generated by Jitendra et al. (2004) include encouraging poor readers to read as much as possible, teaching vocabulary directly and sequentially, and using productive instructional approaches that encourage the improvement of word knowledge acquisition. As reported by Anderson and Nagy (1991) if a fifth grader spends just 25 minutes a day reading independently they will be exposed to over 1 million words and learn over 1000 new words. Encouraging independent reading will expose students to new words but explicit language instruction should still be integrated into the classroom to ensure exposure and acquisition of new words. Through explicit instruction, a student can average 300-400 new words added to their vocabulary annually (Stahl & Shiel, 1999).

In a study comparing a keyword method of instruction to semantic-context instruction, results indicated that participants increased their word meaning understanding through keyword method instruction more significantly (McDaniel et al, 1987). Within the study McDaniel and colleagues provided participants with 30 words for identification through one method of instruction depending on their assigned research group. Using the keyword method, instructors provided the participant with each word and its definition, while the instructor using semantic-context method provided each word in a 3 sentence passage that contained context-clues to the word's meaning (McDaniel, Pressley, & Dungy, 1987). Two experiments were run to support validity of findings and it was determined that participants who were exposed to the keyword method recalled, on average, over 50% of the definitions after the first session while semantic-context participants only recalled about 33.3% initially (McDaniel et al., 1987). However, when participants were administered a delayed-cued-recall test, results were not statistically different which suggests that while use of a keyword method may increase a student's initial vocabulary acquisition, it does not impact retention any more than a semantic-context method (McDaniel et al.,1987). The results of this study suggests that initial acquisition is better with keyword instruction and retention is similar for the two methods, but it does not account for recall skill beyond cued recall (McDaniel et al. 1987).

Reading comprehension is impacted by listening comprehension, and as children reach the higher grade levels, expectations for reading comprehension increase (Barr et al., 2011). If a student has difficulty with either reading or listening comprehension, it can negatively impact their performance in word knowledge. Using the Vocabulary Overview Method (Carr, 1985) students were encouraged to make connections with unknown words and their personal experiences. In the method, students were instructed on a 10 step process that included surveying titles and clues, skimming material, defining terms, filling out a designed overview, making connections, self-monitoring learning, and sharing with the class. While the initial instruction in the Vocabulary Overview Method was intensive and required the instructor to monitor student progress in understanding the method, once mastered the students exhibited success in retaining vocabulary terminology (Carr, 1985). Carr reported that after 4 weeks of students not receiving continued instruction, the students had a vocabulary retention rate of 80% without clues and a 90% recall rate when the student received a clue. The students were actively engaged in their vocabulary acquisition and instruction and it was apparent in their recall results (Carr, 1985).

Learning Disabilities and Vocabulary

Research indicates that there is a strong relationship between word knowledge and academic success (Jackson, 2011). In a study conducted by Hong and Diamond (2012), students who received a combination of explicit language instruction as well as responsive teaching improved their concept vocabulary scores significantly along with their ability to create experiments relating to the content vocabulary compared to peers who continued with either responsive teaching or traditional vocabulary instruction. Students who received both explicit language instruction and responsive teaching performed

50% higher on both concept vocabulary assessments as well as science problem solving assessments when compared to students who did not receive either instructional method (Hong & Diamond, 2012). In order to cultivate a productive learning environment it is necessary for educators to ensure that all of their students' are consistently improving upon their word knowledge and expanding their vocabulary (Bryant, 2003).

Since the passing of the No Child Left Behind Act in 2002 there has been an increase of students with learning disabilities being placed in mainstream content area classes such as science (Seifert &Espin, 2012) which generates even more challenges for educators in terms of differentiating instruction to expand their students' vocabulary. As independent work increases, students are expected to read and acquire information from text on their own (Seifert & Espin, 2012). This proves difficult for students with learning disabilities who tend to avoid reading, and generates a performance gap between the general population of students and students with learning disabilities (Helman et al., 2015).

In order to track student progress, schools are placing more emphasis on outcome-based learning and the performance gap continues to increase for struggling students (Bryant, 2003). Students are consistently being required to take standardized tests that are considered the major indicator in student learning and understanding of material (Seifert & Espin, 2012). The standardized tests generally require that students read questions independently and then respond to either a multiple choice or open-ended response that is evaluated based on key terms used (Bryant, 2003). The performance gap can be attributed to the fact that students with learning disabilities tend to have reading levels lower than their grade-level peers and the gap is indicated by them performing significantly lower on standardized tests (Seifert & Espin, 2012). Appropriate teaching methods need to be identified and utilized in the secondary content classes to bridge the performance gap and encourage students, particularly students with learning disabilities, to increase their word knowledge and reading comprehension.

Jitendra and colleagues conducted a two-experiment study that compared the used of keyword instruction (which included mnemonics and imagery) to direct instruction (which simply includes a picture of the word definition) and reported that in all time-length assessments, the students who were exposed to keyword instruction out-performed their direct instruction peers (2004). Students were assessed at 4 time intervals following instruction; the conclusion of instruction, at the 2 week test, 2 weeks following unit completion, and 8 weeks after unit completion (Jitendra et al., 2004) At each benchmark the students who were instructed through keyword mnemonics and imagery performed significantly higher than those who did not receive this form of instruction (Jitendra et al., 2004). Making associations beyond dictionary definitions and literal images was identified as an effective teaching method for students with learning disabilities within the primary grades (Jitendra et al., 2004).

In a study conducted by Seifert and Espen (2012) it was determined that combined learning conditions of text reading and vocabulary learning generated an increased performance in reading fluency, vocabulary measure, and passage comprehension in relation to science text. Seifert and Espen used a within-subject design and compared the instructional results of working with each student on text reading exclusively, vocabulary learning exclusively, a combination of the text reading and vocabulary learning and no instruction to serve as a control (2012). In terms of vocabulary knowledge, the participants on average generated twice as many correct matches after vocabulary learning instruction and combination instruction in comparison to text reading or the control (Seifert & Espen, 2012). When analyzing passage fluency within the same study (Seifert & Espen, 2012), students read significantly more words correctly within 3 minutes following text reading and combination instructional methods than vocabulary learning or control. Finally, reading comprehension was not significantly impacted by any of the instructional methods used in Seifert and Espen's study (2012). Presenting material in various ways encourages students to be more independent learners and enables them to develop their reading skills within the science classroom and across content (Hong & Diamond, 2012).

When students are provided with multiple opportunities to use a word they are more likely to commit it to memory and retain it for future use (Cohen, 2012). It is crucial that educators provide their students with the opportunity to identify and use their vocabulary terms in an assortment of ways during each class session and also encourage using expanded vocabulary during independent work (Cohen, 2012). Within an inclusive classroom especially, there will be a diversity of learning styles that must be catered to through variation in instruction and repetitive practice (Beach et al., 2015). Inclusive classrooms contain students of varying academic and reading levels so there will need to be more emphasis and variation on explicit vocabulary instruction to ensure proper exposure (Shook, Hazelkorn, &Lozano, 2011). Students with learning disabilities have more difficulty than typical learners extracting word meaning from textbook content (Beach et al., 2015) so it is essential that educators provide these students with the support and instruction that they need. One method for increasing science vocabulary for students with learning disabilities, using collaborative strategic reading, was assessed for efficacy by Shook, Hazelkorn, and Lazano (2011). The findings of Shook and colleagues (2011) suggest that encouraging students to work in mixed level collaborative groups can increase the vocabulary acquisition of both typical students, and students with learning disabilities. Students with learning disabilities improved their average quiz scores by 50 points which closed the performance gap and put them at the same achievement level as their typical peers (Shook et. al., 2011). This collaborative strategic reading requires students to interact with one another can be used in conjunction with the interactive word wall and build upon knowledge acquired through its existence.

Science Instruction

Research suggests that science text contains more complex vocabulary and academic language than text in any of the other content areas (Helman et al., 2015; Barr, Eslami, & Joshi, 2012). 21st Century Skills are focusing on problem solving as an essential skill and are working toward making science more student-centered and inquiry based (Huang et al. 2015). In a study using a 2x2 factorial research design, Huang and colleagues assessed 118 Taiwanese middle school students after they were exposed to a web-based learning module. Students in this study were assessed on knowledge acquisition and cognitive load (2015). The participants were randomly assigned one of four groups and either received problem solving prompts, or no prompts and were combined with either partial or full feedback on their responses (Huang et al., 2015). In terms of knowledge acquisition the students who received problem solving prompts improved their performance, and when paired with correct solution feedback, increased their knowledge acquisition (Huang et al., 2015). With the shift in emphasizing science literacy and problem-solving skills, one must note the importance of science vocabulary understanding to ensure that students are able to participate in this higher-level thinking that is required (Huang et al., 2015; Fisher & Blachowicz, 2013).

Science Vocabulary

Science texts are often written at higher reading levels than the intended audience and contain words, symbols and formulas that relate to one another and are pertinent to understanding the topic (Hooper & Harmon, 2015). According to analysis of the science curriculums of grades 1-8 conducted by Fazio and Gallagher (2013) over 75% of the vocabulary is at a developmental level of 3 or 4. This means that the terminology is morphologically complex and requires a certain level of reading skills (Fazio & Gallagher, 2013) A high school chemistry textbook can contain 3,000 new vocabulary terms and require specific reading skills that are not necessary in other content areas (Barr et al. 2011) Due to the raised reading levels of the text and plethora of new academic vocabulary presented to students, it can be difficult for students to understand concepts if they are unable to master vocabulary acquisition and retention at a similar rate (Fazio & Gallagher, 2013). Students with Learning Disabilities often struggle in science because there is a discrepancy between their reading abilities and the requirements of science curriculum (Seifert & Espin, 2012). Improving the science vocabulary of individuals will encourage an increase in general academic vocabulary (Fisher & Blachowicz, 2013).

In a study conducted by Taboado (2012) involving fifth graders with varying levels of English proficiency, science comprehension was shown to directly connect to general and science vocabulary understanding. The three English language level groups evaluated in Taboado's study (2012) were students who strictly spoke English (EO), students who were learning English (EL) as a second language in a predominantly English area, and students who were learning English as a foreign language (EF) in a predominantly Spanish speaking area. Data collection was done in three stages to determine general vocabulary levels, average reading comprehension, and student questioning. Despite being in two different schools, all participants of Taboado's study (2011) received science instruction for 60 minutes three times a week and were instructed to browse text prior to reading it, to generate questions they may have, and to read the science text. Finally, students were required to answer questions related to the text with the ability to return to the text as reference. Results indicated that while EL students performed lower on general vocabulary compared to the EO students, the differences in performance were not significant in the other categories (Taboado, 2012). The EF students performed significantly lower than both EO and EL students in all examined categories which may be explained by the lack of exposure outside of the classroom (Taboado, 2012) When general vocabulary instruction was increased, students improved their performance in reading comprehension and questioning (Taboado, 2012).

If students lack an understanding of the language of science they are going to have difficulty with the content (Shook et al., 2011). In order to improve science literacy students need to increase their word knowledge so that they are familiar with terminology and comfortable with extracting meaning from context (Fisher & Blachowicz, 2013). Science literacy can be increased through instruction that encourages practice in deriving word meaning from unfamiliar words (Shook et al., 2011). A unique feature of science vocabulary is the use of Greek and Latin roots that can be easily taught to students and can assist them in meaning extraction (Hooper & Harmon, 2015). If students learn the roots, for example-roots that symbolize quantity like mono- means one or thermo- relates to heat, they are able to interpret meanings of words like thermostat (Helman et al., 2015). Having the ability to identify root words provides insight into relationship or numerical values to direct the student understanding (Helman et al., 2015). In a study utilizing a multiple baseline across participants design, Helman and colleagues worked to improve and maintain a mastery level of 80% in science content knowledge of English language learners (2015). Students received 45 minute instructional periods over the course of 2 weeks using Clue Word Strategy (CWS) probes and continued their general vocabulary instruction within their classrooms (Helman et al., 2015). Results of the research show that through instruction using CWS probes all participants significantly improved their morphological and contextual abilities in terms of science vocabulary with 66.6% of the participants able to maintain those skills. Science vocabulary not only includes content specific terminology, but incorporates general academic terms that can be considered cross-content such as *analyze* or s*ignificant* (Hooper & Harmon, 2015). Providing explicit instruction in science vocabulary could potentially improve the word knowledge of students in science as well as other content areas.

Shore and colleagues looked to identify the most effective explicit vocabulary instruction method within 7th grade science classrooms (2015). Over the course of 9 weeks, teachers implemented 1 of 3 methods of instruction for a 3 week time frame; Conversation, Pictionary, or Dictionary (Shore et al., 2015). When students were utilizing the conversation method, they looked up the definition and then discussed and rephrased the definition with their peers in close proximity. The results showed this to be the least effective method in terms of both short-term recall and retention of the target vocabulary. The data collected by Shore and colleagues (2015) suggests that initial recall and retention was highest when students utilized the Pictionary method which required more instructional time but allowed the students to draw images that helped them to recall the word (not necessarily an image of the word). Moreover, student retention was significantly greater than their initial recall when they used the dictionary method (e.g. used the glossary to identify the definition of a word); however, this was also identified as the approach that students liked the least (Shore et al., 2015). In terms of order of preference the 7th grade students who participated in the study listed Pictionary first, followed by Conversation, and then Dictionary as their preference for vocabulary learning (Shore et al., 2015). Making picture connections or talking about words are student's preferred methods of connection to new terminology and making picture connections proved to be the most effective method in all three assessment areas (Shore et al., 2015).

Word Walls

Word walls provide references that enable students to become more independent and strategic problem solvers as they read and write (Brahbram, 2001). The term word wall can generate a variety of ideas amongst people because of its use as a fairly generic term (Brahbram, 2001). Word walls can be teacher generated or student developed depending on the design (Hooper & Harmon, 2015). Traditionally, word walls are simply key terms displayed in the classroom in large font so the students can see when they are in the classroom (Jackson 2011). Figure 1 provides a visual illustration of what is considered a traditional word wall. This wall merely displays the words and does not provide any support or information regarding meaning or relationship. Alternatively word walls have developed into more detailed, visually appealing teaching tools that encourage word and image connections (Jackson et al., 2011). This type of word wall is termed *interactive word wall* (see Figure 2) due to the nature of the conceptualization, generation, and application. Interactive word walls encourage the students to visually organize the new terms, relate the new terms to one another, and use the terms throughout lessons (Jackson et al. 2015). Displaying and connecting information using interactive word walls provides students the opportunity to identify important words and ideas while linking those ideas to one another and creating connections (Heinrichs & Jackson, 2012).

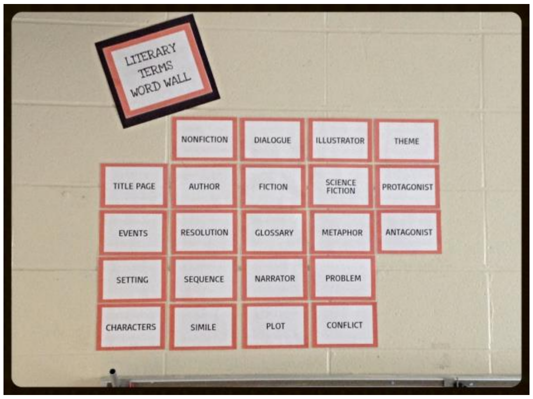

Figure. 1 Example of a traditional word wall. Adapted from “Birth of a Middle School Word Wall” by R. Stewart, 2015. Scholastic.com

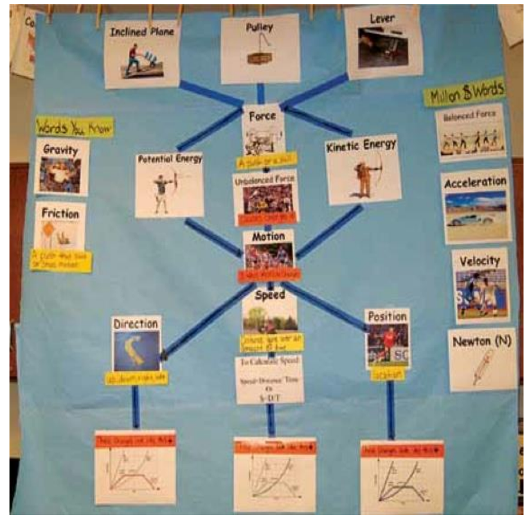

Figure. 2 Example of an interactive word wall. Adapted from “Putting science words on the wall” by M. Bigelow, 2013. nstacommunities.org

Exposing students to the words on a daily basis through word walls allows them to see new terms and potentially reminds the students to incorporate the words into their work (Vintinner, Harmon, Wood, & Stover, 2015). Vintinner and colleagues recruited, instructed, and interviewed 5 secondary teachers regarding the use of interactive word walls within their classrooms (2015). Prior to the implementation the teachers reported thinking that vocabulary instruction was the responsibility of the primary school teachers and not really something they should be focusing on in their classroom (Vintinner et al., 2015). Following implementation of interactive word walls within their classroom over the course of 6 weeks, these same instructors reported having differing opinions relating to vocabulary instruction and were pleased with the positive impact that the interactive word walls had on their class (Vintinner et al., 2015). Teachers that had once considered word walls to be something that would not improve their classroom reported that following the incorporation of interactive word walls resulted in the students demonstrating greater vocabulary acquisition and willingness to include their expanded vocabulary in their work, and served as a positive formative assessment tool for them (Vintinner et al., 2015) Referring to a previous study conducted by Jackson and colleagues, Hooper and Harmon (2015) state that repeated and consistent exposure to terminology along with visual clues through an interactive word wall can assist students in developing a deeper understanding of science concepts and increase science-related vocabulary. According to Yates, Cuthrell, & Rose (2011), an eighth grade group that was exposed to a cross-content word wall in their hallways and classrooms increased their end of the year test scores and were documented as properly identifying and using the terms on a regular basis. Eighth grade students who used interactive word walls in the hallway and in individual classrooms improved their reading proficiency scores by 12%, their math proficiency skills by 16%, and their science proficiency by almost 18% (Yates et. all. 2012). The teachers that participated in the study conducted by Yates and colleagues (2012) reported that students were actively involved in creating and adding to the word wall as well as identifying and using the words in their daily lives.

Not only do word walls provide daily visual reminders, but interactive word walls serve as timelines that document the class' knowledge acquisition chronologically as it is presented (Heinrichs & Jackson, 2012). Updating and maintaining the wall can provide students with visual confirmation that they are acquiring new knowledge and they can be consistently reminded of accomplishments through the year in terms of building their science understanding (Heinrichs & Jackson, 2012). Providing students with this reminder serves to continue to motivate them and encourages them to continue with their vocabulary acquisition and ultimately improves academic success (Fisher & Blachowicz, 2013). In surveying 6^{th} and 8^{th} grade students Jackson and colleagues (2011) reported an overwhelmingly positive response to the use of the interactive word walls. Students' responses included being happy with having the ability to turn and look for reminders, and having a picture to remember was good and useful. Some students are more successful when they can associate images with words; when used correctly, interactive word walls provide visual connection and graphic organization that improves vocabulary retention for these visual learners (Jackson et al., 2011).

Jackson and colleagues (2011) generated a rubric identifying six criteria that are necessary for creating the most effective word walls: (1) academic vocabulary is posted, (2) words are aligned with current instruction, (3) words are visible from a distance, (4) words are arranged to illustrate relationships and organize learning, (5) wall contains student-generated material, and (6) visual supports are color pictures, photographs, or actual items.

In a study reported by McDaniel and colleagues (1998) that compared vocabulary retention through keyword mnemonics with learning definitions through content, data suggested that the long term vocabulary retention resulting from both approaches was statistically similar. Since students in special education classes often have various learning needs it is necessary for teachers to provide instruction that caters to diverse learning styles (Jitendra et al., 2004).

Conclusion

Vocabulary is an integral part of reading and understanding content material but teachers at the secondary level often struggle to find time to integrate explicit vocabulary instruction into the classroom (Carr, 1985). Data collected by the National Research Center in 1998 reveals that 80% of all students who are diagnosed with a learning disability have difficulties with reading (Bryant, 2003). Connecting new vocabulary with background knowledge, generating semantic relationships through activities like semantic mapping, using a combination of dictionary definitions and incorporating synonyms and antonyms to vocabulary instruction are strategies that have been identified by research as productive strategies (Barr et al., 2011). Improving upon students reading skills through conducting explicit vocabulary instruction should create more confident and successful students in the science classroom and beyond (Fisher & Blachowicz, 2013).

One way to integrate explicit language instruction is by creating a print-rich environment to address the needs for vocabulary instruction (Vintinner et al., 2015). Word walls generate a print-rich environment and provide various learning and exposure opportunities for students with diverse learning needs (Hooper & Harmon, 2015). Research supports that a combination of explicit language instruction methods provides the most effective results in terms of both vocabulary acquisition and retention (Heinrichs & Jackson, 2012; Hooper & Harmon, 2015; Jackson et al., 2011).

Providing various instructional methods will enable all learners to connect with the information. Interactive word walls encourage the use of varied instructional methods through student participation in generation of wall and repeated exposure and practice within each classroom session (Brahbram, 2001). Traditional and Interactive Word Walls have shown their effectiveness at the elementary level in a variety of studies, yet research is limited at the high school level (Brahbram, 2001; Heinrichs & Jackson, 2012; Yates et al., 2011). Students up through grade eight have expressed positive opinions towards the use of word walls in terms of comprehension and vocabulary acquisition (Hooper & Harmon, 2015) and further research appears warranted to determine the efficacy of this method at the secondary level and with students with learning disabilities. This study aims to investigate the impact of an interactive word wall on the vocabulary retention and reading comprehension of students with learning disabilities in a high school science classroom.

Chapter 3

Methodology

Settings and Participants

This study took place during two Special Education departmentalized Chemistry classes within a New Jersey High School. The school is located in Jersey City, New Jersey and serves as a select school for approximately 800 students from across Hudson County. Within this school students are accepted into major vocational programs like dance, culinary arts, photography, cosmetology, and environmental science that they work to complete in conjunction with the required academic courses. All study participants have an Individualized Education Plan to assist in their academic success. Topics that were covered in class and were to be enhanced by the vocabulary emphasis included stoichiometry and molar relationships within chemical reactions.

A total of twenty tenth grade students were approved for participation and were split into two groups based on class schedule. To ensure confidentiality, students who participated in the study were each assigned an identification letter and all materials were labeled with the letter only.

Experimental Design

The experiment utilized quasi-experimental pre-post test comparison group design using interrupted time-series (Johnson & Christiensen, 2007) due to the inability to randomize participants and establish a clear control group. The intervention was alternated for two units between comparison groups to control for the potential differences in difficulty of the vocabulary. Data was collected for individual achievements and then analyzed between group for determination of word wall efficacy. The opinions of the students were also recorded through use of a satisfaction scale and written response. The implementation of the word wall intervention across comparison groups is displayed in Table 1.

Table 1

Intervention Actions

	Unit 1			**Unit 2**			**Unit 3**			**Unit 4**		
Group	Pre test	*Word Wall*	Post test	Pre test	*Word Wall*	Post test	Pre test	*Word Wall*	Post test	Pre test	*Word Wall*	Post test
1	O		O	O	X	O	O		O	O	X	O
2	O		O	O		O	O	X	O	O	X	O

Note: The “x” indicates use

Variables

The independent variable in this experiment is the use of an interactive word wall to enhance the introduction of new vocabulary terminology and instruction in a science classroom. The dependent variables that were measured and recorded were vocabulary retention and reading comprehension. Vocabulary retention was measured by students completing word to definition matching. Reading comprehension was measured by completion of fill in the blank sentences with the best possible vocabulary term.

Procedure

Students in group A were in class for 5 days a week from 9:54am to 10:34am and students in Group B were in class for the same number of days from 12:57pm to 1:37pm. Data collection occurred over 50 days. At the beginning of each instructional method/unit of study, participants were administered a vocabulary assessment to determine familiarity with words prior to instruction. The baseline data was collected for Group 1 and Group 2 simultaneously with Group 2's baseline data collection occurring over 2 units as opposed to a single unit (see Appendix A for sample pre-test) By conducting the study in this manner it addressed the concern that the science vocabulary terms during different treatment scenarios may be the cause for any differences in performance. Following the pre-test, two weeks of instruction occurred where participants were either working to increase their science vocabulary knowledge through traditional instructional techniques or through use of interactive word walls.

The baseline instruction presented the terms and required participants to define and study the terms independently with use of the words being integrated into instruction over the course of the academic unit. The participants were exposed to the terms but did not receive explicit vocabulary instruction for the two week time frame. The interactive word wall treatment period provided visual exposure to the terms for the participants daily (5 days per week) for two weeks and had the participants drawing relations between words, adding images to words to assist them in remembering them, and performing short tasks related to the words. Participants were able to make associations, visualizations, and interactions for the entirety of their time within the science classroom (forty minutes per day). The interactive word wall was constructed by the students and displayed for students when in the experimental method phase and was removed when the class was serving as a control.

At the conclusion of the instructional method there were two assessments that participants completed independently. The first assessment was to identify vocabulary retention via an assessment in which the participants matched each term to its definition. The second assessment required the participant to properly place each vocabulary term in the best sentence. The retention assessment was administered in twenty minutes time for completion and the comprehension assessment was given thirty minutes to complete. Data was collected and assessed in terms of individual achievement and average percentage correct. At the conclusion of four units of data collection each participant was provided with a questionnaire that allowed them to express their opinion on the use of interactive word walls in the secondary science classroom.

Results were compared within group and between groups. Comparing pretest and post treatment assessments allowed for investigation of whether any teaching method demonstrated a more positive impact on vocabulary retention and reading comprehension. The matching assessment served as the indicator for vocabulary retention and the sentence completion assessment served as the indicator for reading comprehension.

The study took place over the course of four vocabulary units. The timeline and instructional method each group was exposed to can be seen in Table 1. All assessments were completed independently. Participants demonstrated their vocabulary retention through completion of a twenty minute timed matching quiz and their reading comprehension through a fill in the blank quiz.

Chapter 4

Results

In this study the effects of interactive word walls on student vocabulary retention and reading comprehension were analyzed. Two chemistry classes of special education students were the participants with each group experiencing different instructional strategies for two segments and receiving the same instruction for the final assessment.

The research questions to be answered were:

1. Will the use of interactive word walls in the science classroom impact the vocabulary retention of students with learning disabilities?
2. Will the use of interactive word walls in the science classroom impact the reading comprehension of students with learning disabilities?
3. Are secondary students with learning disabilities satisfied with the use of interactive word walls to foster vocabulary retention and reading comprehension in the science classroom?

The study began with all groups being introduced to the same vocabulary terms and encouraged to study those terms on their own for two weeks followed by an assessment. To track progress students were also required to complete pre-assessments as baseline for understanding the impact of the interactive word wall.

Table 2 provides the data for percentage correct on the vocabulary retention assessments. A series of t-tests comparing the results between groups demonstrated no statistical significance when comparing the change from pre to post assessment between instructional methods with the p-value of Unit 2 being 0.397 and Unit 3 being 0.460.

Table 2

Vocabulary Retention Assessment Results

		Unit 1		Unit 2		Unit 3		Unit 4	
Student		Pre (%)	Post (%)	Pre (%)	Post (%)	Pre (%)	Post (%)	Pre (%)	Post (%)
Group 1	A	27	9	9	45	25	17	18	45
	B	55	82	18	18	0	17	18	45
	C	45	64	0	27	25	17	36	82
	D	36	64	45	9	17	42	55	91
	E	55	55	45	27	8	17	18	91
	F	64	73	36	64	50	67	45	100
	G	9	36	27	27	0	17	18	45
	H	73	9	18	36	0	75	18	100
	I	27	27	9	54	17	50	9	54
	J	9	36	27	45	0	25	18	100
Group 2	K	36	45	27	45	17	17	27	91
	L	0	0	9	0	17	42	27	54
	M	27	82	45	45	67	83	36	82
	N	82	100	91	82	67	83	73	100
	O	64	100	64	55	75	75	64	100
	P	0	36	27	36	33	25	27	45
	Q	82	100	55	55	0	75	27	82
	R	73	100	36	45	67	50	36	73
	S	36	45	0	55	17	75	18	91
	T	18	64	0	27	0	25	18	64

Table 3 shows the results of the reading comprehension assessments and demonstrates similar findings with only Unit 3 showing statistical significance (p = 0.044).

Table 3

Reading Comprehension Assessment Results

		Unit 1		Unit 2		Unit 3		Unit 4	
STUDENT		Pre (%)	Post (%)	Pre (%)	Post (%)	Pre (%)	Post (%)	Pre (%)	Post (%)
Group 1	A	0	45	20	36	0	8	40	44
	B	0	82	20	73	0	33	0	67
	C	20	55	0	18	0	33	20	44
	D	20	55	60	0	0	58	20	44
	E	0	55	20	27	40	42	0	33
	F	0	82	0	27	0	50	20	33
	G	0	64	0	18	0	17	0	33
	H	40	64	60	73	20	33	40	67
	I	20	64	20	18	0	67	40	67
	J	20	55	40	0	20	8	40	56
Group 2	K	60	45	20	82	0	8	20	11
	L	0	82	20	0	0	42	20	33
	M	0	82	0	27	40	100	20	56
	N	60	100	80	64	40	66	40	78
	O	60	100	0	55	20	75	0	67
	P	0	36	0	27	0	42	0	44
	Q	80	100	0	45	0	83	40	78
	R	40	100	20	55	0	66	0	56
	S	40	73	40	45	20	75	0	56
	T	0	36	40	9	0	33	40	33

Tables 4 and 5 show the mean results for each unit of assessments. There is a mean improvement in results despite the lack of statistical significance.

Table 4

Mean Group Results Vocabulary Retention

	Unit 1		Unit 2		Unit 3		Unit 4	
	Pre (%)	Post (%)	Pre (%)	Post (%)	Pre (%)	Post (%)	Pre (%)	Post (%)
Group 1	12	62.1	**24**	**29**	8	34.9	**22**	**46.17**
Group 2	34	75.4	22	40.9	**12**	**59**	**18**	**47**

Note: Scores in **Bold** indicate use of Word Walls

Table 5

Mean Group Results Reading Comprehension

	Unit 1		Unit 2		Unit 3		Unit 4	
	Pre (%)	Post (%)	Pre (%)	Post (%)	Pre (%)	Post (%)	Pre (%)	Post (%)
Group 1	40	45.5	**23.4**	**35.2**	14.2	34.4	**25.3**	**95.5**
Group 2	41.8	67.2	35.4	44.5	**36**	**55**	**35.2**	**86.5**

Note: Scores in **Bold** indicate use of Word Walls

Figure 3 illustrates the mean scores on vocabulary retention assessments for both groups through the units. During unit 2, Group 1 used the Word Walls, during Unit 3 Group 2 used Word Walls, and during Unit 4 both groups utilized Word Walls. Regardless of the instructional method Group 2 mean scores were higher than students in Group 1 on vocabulary retention assessments.

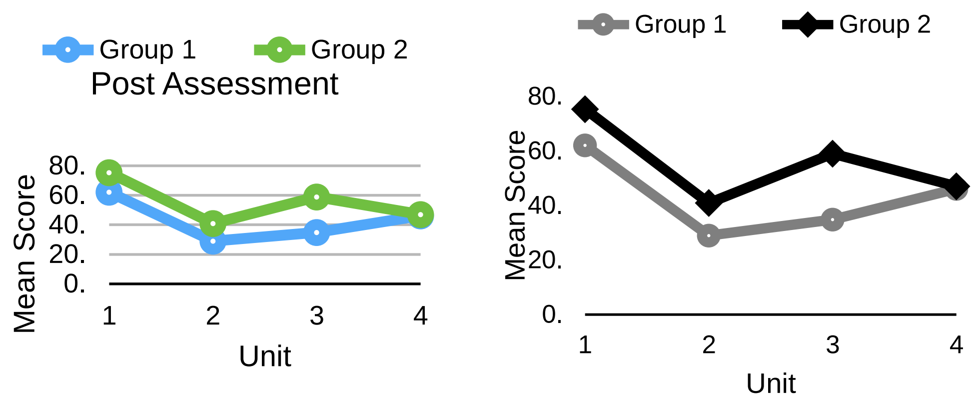

Figure 3. Vocabulary Retention Results. Left: Pre-Assessment, Right: Post-Assessment

Figure 4 illustrates the mean pre and post assessment scores across the units for both Groups 1 and 2. During Unit 2, Group 1 used the Word Walls. During Unit 3, Group 2 used Word Walls, and during Unit 4 both groups utilized Word Walls. Despite the instructional approach students in Group 2 scored higher than students in Group 1.

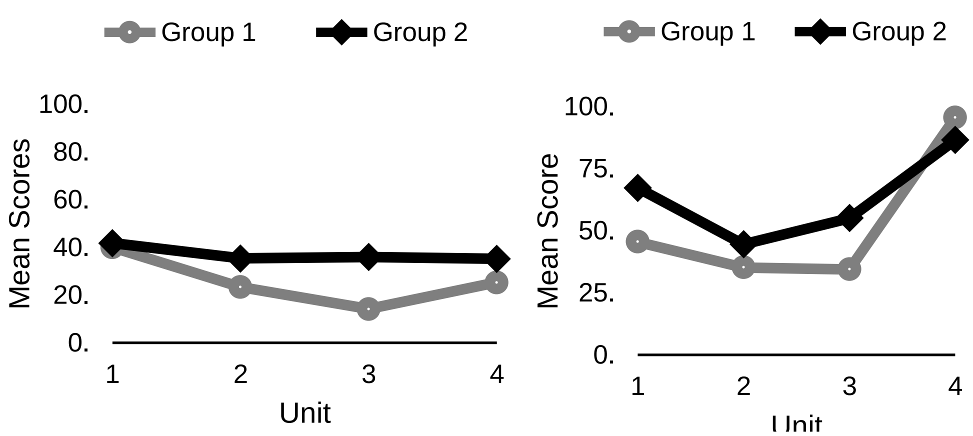

Figure 4. Reading Comprehension Results. Left: Pre-Assessment, Right: Post-Assessment

Figure 5 illustrates the mean change in scores from the pre to post assessment across the units. During Unit 2 Group 1 used the Word Walls, During Unit 3 Group 2 used Word Walls, and during Unit 4 both groups utilized Word Walls. Group 1 showed a larger score improvement in reading comprehension for units 2, 3, and 4.

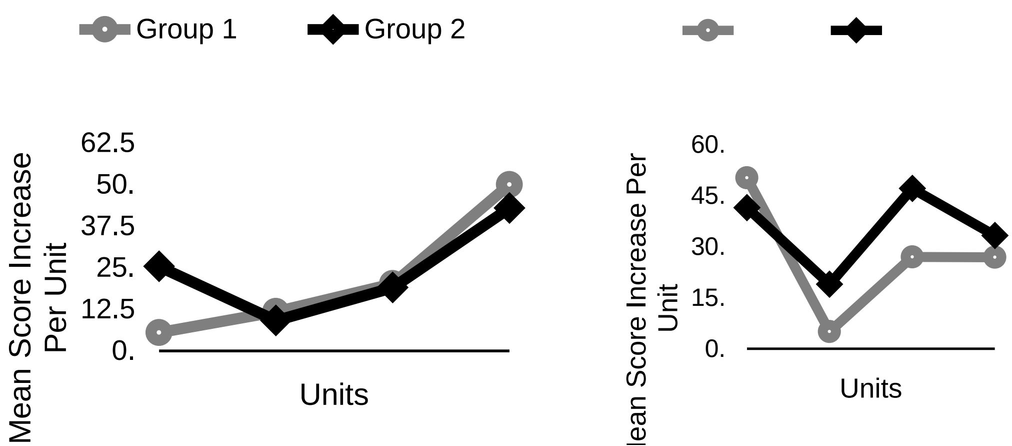

Figure 5. Mean score differences from pre to post-assessment.
Left: Vocabulary Retention. Right: Reading Comprehension

Finally, students were asked to complete a satisfaction survey relating to their experience with Interactive Word Walls in the Science Classroom and the results can be seen in Table 6. 85% of participants reported a higher comfort in using vocabulary terms because of using the Word Wall. In terms of usefulness in the high school classroom, 90% of the participants reported that they felt an Interactive Word Wall is useful in the classroom. Seventy-five percent of participants reported that the word walls helped them remember vocabulary definitions.

Table 6

Satisfaction Survey Results

Questions	Disagree very much (%)	Disagree moderately (%)	Disagree Slightly (%)	Agree Slightly (%)	Agree moderately (%)	Agree very much (%)
I feel that the word wall helped me remember vocabulary definitions.	0	15	10	10	45	20
I was more comfortable using vocabulary words because of the word wall.	0	5	10	20	50	15
Interactive Word Walls are useful in high school	0	10	0	15	35	40
I felt that the word walls were challenging but useful	5	20	5	40	30	0
I would like to use word walls in future classes	5	0	15	15	55	10

A detailed discussion of the results is provided in the subsequent chapter. There was no statistical significance for using word walls versus traditional vocabulary instruction for either reading comprehension or vocabulary retention. Despite these results, at least 70% of students reported satisfaction with the use of the Interactive Word Walls. Identifying effective vocabulary instructional methods could have positive impacts on the education of students with learning disabilities.

Chapter 5

Discussion

Identifying effective vocabulary instruction that appeals to high school special education students is a challenge that many high school teachers face on a regular basis. Research indicates that extending adolescents' vocabulary knowledge through direct and explicit vocabulary instruction is a worthwhile endeavor for all subject area teachers, including teachers of struggling readers and students with a learning disabilities (Beach et al., 2015). The purpose of this study was to determine the efficacy of word walls in science vocabulary instruction in the high school special education science classroom. Interactive word walls combine multiple instructional strategies and create a print-rich environment for learning, while encouraging students to use vocabulary terms regularly throughout the instructional period and beyond (Jackson et al. 2011; Brahbam, 2001). Three specific research questions were considered:

1. Will the use of interactive word walls in the science classroom impact the vocabulary retention of students with learning disabilities?
2. Will the use of interactive word walls in the science classroom impact the reading comprehension of students with learning disabilities?
3. Are secondary students with learning disabilities satisfied with the use of interactive word walls to foster vocabulary retention and reading comprehension in the science classroom?

Vocabulary Retention

Participants' vocabulary retention was assessed using percentage of correct answers when matching each vocabulary term to its correct definition. When comparing the results from units 2 and 3 (where groups received different instructional methods) there was no statistical significance between mean score improvements. Looking at individual students in Table 2, there are a number of participants that responded well to the use of Interactive Word Walls based upon their individual scores across the units. Participants F, J, M, and N show large score improvements when utilizing the word wall versus traditional instructional methods. Group 1 generally performed lower than Group 2 but when utilizing the word walls, the performance gap was decreased. When Group 1 was not utilizing the word wall the difference between groups was approximately 20 points; however, when Group 1 was utilizing the word wall, the assessment difference was less than 10 points. Despite the intervention not being statistically significant, this suggests there were improvements that may be credited to the use of Interactive Word Walls. It is also important to note that 75% of the students reported that the Interactive Word Wall helped them remember vocabulary definitions.

Reading Comprehension

Research indicates that there is a strong relationship between word knowledge and academic success (Jackson, 2011) Accessing reading comprehension in relation to science vocabulary can indicate a base of word knowledge and may correlate to academic success. To assess the reading comprehension participants completed a collection of sentences with the proper vocabulary term. Eighty-five percent of the participants reported that using the Interactive Word Wall helped increase their comfort in using the new science vocabulary. Even though participants responded positively to the use of the Interactive Word Walls in terms of personal satisfaction, 5 participants actually decreased their scores from the pre to post assessments when utilizing the word walls. This decline in comprehension scores may be the result of the assessment method and further investigation is recommended to determine other possible contributing factors.

Student Satisfaction

While assessment scores indicated no major difference between scores for both vocabulary retention and reading comprehension, the majority of the students reported they found that the Interactive Word Walls were useful for remembering vocabulary definitions. Furthermore, 75% of participants indicated that the Interactive Word Wall helped them remember definitions for their vocabulary words, and 85% of participants agreed that the Interactive Word Wall helped them feel more comfortable in using the introduced vocabulary terms. Participants also agreed the most with the statement "Interactive Word Walls are useful in high school" with 90% agreement. Finally 80% of participants indicated that they would like to use Interactive Word Walls in future classes.

With such a positive response to the use of Interactive Word Walls it seems that this method of instruction could positively impact classroom performance despite the results of this study. When students are provided with multiple opportunities to use a word they are more likely to commit it to memory and retain it for future use (Cohen, 2012). The majority of participants reported they were able to remember definitions, and were more comfortable with new terminology when they were exposed to the Interactive Word Wall.

Limitations and Recommendations

Major limitations to this study include the time frame in which the research was conducted, and the time of the school year. Research began with only ten weeks left in the school year at the end of the year when students tend to decrease effort and may struggle with staying focused in the classroom. Along with time, the inability to separate the groups randomly limited the choice of the research design. A larger sample size separated into random groups may provide different results. Recommendations for future studies also include conducting the study at the beginning of a school year and for an extended period of time, and varying the assessment methods. A variety of assessments, including brief electronic assessments that occur more frequently over each unit of study may increase the strength of supporting data.

Although data from this study does not demonstrate a significant connection between the use of Interactive Word Walls and student success in vocabulary retention and reading comprehension, students responded positively to its use. With at least 70% of the participants responding positively, there is reason to pursue continued assessment of the use of Interactive Word Walls to increase student vocabulary retention and reading comprehension in the special education science classroom.

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Appendix A

Unit 2 Pre-Assessment Vocabulary Retention

Participant:_________
a. composition stoichometry
b.reaction stoichiometry
c.stoichiometry
d.reactant
e.product
f.mole-mass problems
g.chemical reaction
h.coefficient
i.conversion factor
j.molar mass
k.mole ratio

Match the word to the definition.

____1. a process in which the atoms of one or more substances are rearranged t form different substances

____2. The portion of chemistry involving the calculation of quantities of substances involved in chemical reactions (and numerical relationships in chemical reactions).

____3. Calculations involving the mass relationship between reactants and products in a chemical reaction.

____4. Ratio between the numbers of moles of any two of the substances in a balanced chemical equation.

____ 5. the starting substance in a chemical reaction

____6. the arithmetical multiplier for converting a quantity expressed in one set of units into an equivalent expressed in another

____ 7. When you are given the moles of one substance and need to find the mass of another substance involved in the same reaction

____ 8. Conversion factor derived from the coefficients of a balanced chemical equation interpreted in terms of moles.

____ 9. calculations involving the mass relationships of elements in compounds

____10. The ending substance in a chemical reaction

____11. the mass in grams of one mole of a substance

Appendix B

Unit 2 Pre-Assessment Reading Comprehension

Participant:________

Use the vocabulary on the board, to select the best word to complete the sentence.

12. In the reaction $2Fe + 3Cl_2 \longrightarrow 2FeCl_3$, Fe is a ____________________________.

13. ____ works with conversions of substances from the coefficients of a balanced chemical equation.

14. When trying to transition from one mole of a substance to another mole of a substance you can use the coefficients set up as a ____.

15. The average of the mass of all elements involved in constructing a compound is the ____________________.

16. In the reaction $2Fe + 3Cl_2 \longrightarrow 2\ FeCl_3$, $FeCl_3$ is the

_______________________________.

17. When two or more elements combine to form another substance the process can be shown in a balanced ____________________________________.

18.____________________________ is the process by which scientists use the numerical values of substances involved in a chemical reaction to determine availability or requirements of substances.

19. The numbers located in front of the reactants and products that are called ______________ and are used to identify the number of moles of each substance.

20. A relationship that shows two measurements that are equal to one another that is used to changed units is called a

____.

21. When an individual knows the number of moles of substance A in a reaction and is looking to find the mass of substance B that is needed they can use a ________________________ _______________________ to calculate and identify the unknown.

22.____ works with the elements of a reaction and their molar masses.