Hammill Institute on Disabilities

Remedial and Special Education
33(1) 39–47

DOI: 10.1177/0741932510362515
http://rase.sagepub.com
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Comparing Whole-Word and Morphograph Instruction During Computer-Assisted Peer Tutoring on Students' Acquisition and Generalization of Vocabulary

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Abstract

Students with disabilities often have large vocabulary deficits that continue to increase over time if effective interventions that supplement daily academic instruction are not put in place. The current study used a simultaneous treatments design to analyze the comparative effects of whole-word vocabulary instruction and morphograph instruction on students' vocabulary acquisition and generalization through the use of a computer-assisted peer-tutoring program. Seven of eight middle school participants with mild disabilities involved in this study acquired higher percentages of vocabulary in the morphograph condition compared to the whole-word condition. All eight students were better able to generalize to unknown vocabulary in the morphograph condition. This study's findings indicate a functional relationship between morphograph instruction and the acquisition and generalization of vocabulary.

Keywords

morphograph, vocabulary, peer tutoring, computer-assisted instruction

Vocabulary knowledge greatly contributes to text comprehension and overall reading achievement (Medo & Ryder, 1993; Nagy, 1988; Stahl, 2003). Students who have limited vocabulary knowledge often struggle with content-area reading comprehension (Bryant, Ugel, Thompson, & Hamff, 1999). Research has shown that the rate at which students acquire vocabulary varies tremendously; students with reading disabilities tend to have poor vocabularies because of their limited involvement with reading activities, and the vocabulary gap between good readers and poor readers increasingly widens over time (Bryant et al., 1999). Therefore, it is critical that struggling readers receive instruction specifically targeted for vocabulary.

Teachers often use a variety of strategies to increase students' vocabulary knowledge (e.g., definition, context, prereading, incidental exposure, keyword method), but there has been insufficient empirical support to suggest any one strategy as superior to others in promoting vocabulary growth (National Reading Panel, 2000). The National Reading Panel (2000) suggested that strategies for teaching vocabulary vary widely and stressed a great need for research in vocabulary instruction.

The National Institute for Literacy (2003) recognized that knowledge of some common prefixes and suffixes (affixes), base words, and roots can help students learn the meaning of many new words. A *morpheme* is the most elemental spoken unit that has meaning. Teaching vocabulary through the study of words parts or morphemes is one approach that has some empirical and authoritative support for enhancing regular vocabulary instruction (Carlisle, 2000; Wysocki & Jenkins, 1987). Their counterparts in writing are referred to as *morphographs*. All words are composed of one or more morphograph (Dixon, 1991). Morphological knowledge supports the process of learning to decode written words and facilitates both word reading and understanding of words and texts (Carlisle, 2003).

A number of authorities have posited that morphological knowledge plays a role in students' word reading and

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comprehension (Carlisle, 2000; Dixon, 1991; Moats, 2000; Nagy, Berninger, & Abbott, 2006). Moats (2000) contended that knowledge of word meaning, rapid word recognition, and spelling ability greatly depend on knowledge of word structure at the level of morphemes. In spite of authoritative support spanning more than two decades for teaching morphemes or morphographs, there has been little empirical support for the possible benefits of morphograph instruction for learners with or without disabilities (Dixon, 1991).

Wysocki and Jenkins (1987) investigated the extent to which morphological generalization could account for increases in vocabulary size. The study tested students' ability to use morphological and contextual information to determine the meaning of unknown words. Results showed that students were able to make use of knowledge of word structure to infer the meaning of the unknown words. In a similar study, Carlisle (2000) analyzed the effects of morphological awareness on word reading and reading comprehension with a group of third and fifth graders. Results showed that awareness of structure and meanings of derived words were significantly related to the ability to define morphologically complex words. Despite these promising results, more research needs to address the potential benefits of morphograph instruction on vocabulary acquisition and generalization compared to traditional approaches to vocabulary instruction (e.g., whole word).

In addition to considerations regarding the strategy for teaching new vocabulary, the National Reading Panel (2000) suggested that decisions regarding task presentation (e.g., learning strategies, context, computer technology) need to be made. Explicit instruction of roots and affixes could be done through presentation and creation of oral and written examples in context (Moats, 2000). Carnine, Silbert, Kame'enui, and Tarver (2004) recommended directly teaching the most commonly used morphemes (e.g., *co*, *pre*, *able*). According to an analysis by Moats (2000), if students receive direct instruction in the meanings of the most commonly used prefixes, identification of base words when common suffixes are removed, and the spelling changes associated with the addition of inflections beginning with vowels, they can successfully analyze 250 new printed words per year through morphological analysis.

One efficient learning strategy that increases task engagement and the number of opportunities for practice is reciprocal peer tutoring (Heron, Villareal, Yao, Christianson, & Heron, 2006; Maheady, Mallette, & Harper, 2006). Peer tutoring is an evidence-based strategy that increases active student engagement and provides multiple opportunities to practice academic content with immediate delivery of corrective feedback (Heron et al., 2006; Maheady et al., 2006). One limitation of peer tutoring is that the tutor needs to have available the correct response to provide accurate feedback. This can be difficult when working with a population with limited reading skills. One solution is to make correct responses available through audio feedback (Van Norman & Wood, 2008). This changes the role of the tutor to concurrent learner, provider of social reinforcers, and audience, which may help the learner to attempt responses before using audio feedback.

Using computers for this purpose is efficient and advantageous. Computer-assisted instruction is an individualized approach that can reach students at all levels (Kolich, 1991). Some studies suggest that computer-assisted vocabulary instruction shows positive learning gains over traditional methods (Davidson, Elcock, & Noyes, 1996; Heise, Papelewis, & Tanner, 1991; Heller, Sturner, Funk, & Feezor, 1993; Reinking & Rickman, 1990). The purpose of this study was to add morphograph instruction to current and recommended practices for teaching vocabulary and to determine its effects on the acquisition and generalization of vocabulary. The research questions for this study were as follows:

1. To what extent does teaching the meaning of morphographs result in higher acquisition of vocabulary than when students are taught word meaning without attention to morphographs?
2. To what extent does teaching the meaning of morphographs result in greater acquisition of novel words with those morphographs than when students are taught without attention to morphographs?
3. Which method of instruction do students prefer?

Method

Participants and Setting

The students were 8 seventh grade students (5 boys, 3 girls) ranging in age from 12 to 15 years. Students who were identified as having a disability under the Individuals With Disabilities Education Improvement Act (2004) were specifically chosen for this study. Of the participants, 4 were identified as having an other health impairment, 1 participant had an emotional or behavioral disorder, and 3 participants had a specific learning disability. Of the participants, 2 were African American, 5 were Caucasian, and 1 was Hispanic. The students were included in general education classrooms and received small-group instruction in language arts and math in the special education resource room. According to their most recent individualized education programs (IEPs), all participants were functioning at least one level or more below grade level in reading. Each student also had an IEP goal that addressed increasing his or her vocabulary acquisition as well as improving comprehension of unknown vocabulary in the context of printed material. Table 1 summarizes students' demographic information.

Table 1. Student Demographic Information

Student	Age	Ethnicity	Disability	Reading Grade Level
Adrienne	12	Hispanic	SLD	4.9
Sean	15	Caucasian	OHI	4.3
Jacob	12	Caucasian	SLD	4.1
Drew	14	Caucasian	OHI	4.8
Jasmine	13	Caucasian	EBD	4.7
Taylor	13	African American	SLD	3.8
Alisha	15	African American	OHI	6.0
Wesley	15	Caucasian	OHI	5.4

Note: SLD = specific learning disability; OHI = other health impaired; EBD = emotional or behavioral disorder.

The setting was a public middle school in a small rural town located in the southeastern United States. The school included many students who came from families with low socioeconomic status, and more than 65% of the students received free or reduced-price lunch. All sessions of the study were delivered in the school's resource room. The resource classroom was an 18 ft × 20 ft room that contained desks, instructional materials, a desktop personal computer, and a laptop computer. A video camera was used to record tutoring sessions and probes. For the tutoring sessions, only one pair of students was in the resource classroom at a time. For the pretests and probes, all eight students were in the resource classroom at one time.

Measures

Pretests. The experimenter (second author) created 48-item pretests given at the beginning of the study and following every two tutoring sessions. An item contained a sentence with a blank for which a vocabulary word would be selected to complete the sentence. Each sentence was composed so there was sufficient context to predict the missing vocabulary word, if familiar to the student. In addition, each item contained the correct vocabulary word and three distractors, all with morphographs, that would be a focus of the next two sessions. The experimenter mixed the position of the correct vocabulary selection across items. Of the 48 pretest items, 8 contained less complex sentence structures and easier, nontargeted vocabulary words that included the same morphographs. These items were interspersed within the pretest to decrease frustration level and ensure some success for the students. After assessing the pretest scores for each student, the experimenter discarded a maximum of 2 words per morphograph (8 total from the 40 words) that were known by the majority of the students to ensure that words already known by the students would not be used for instruction or generalization. The remaining 8 words per morphograph (32 total) were used in the subsequent set of two tutorial sessions and and in the probe.

Probes. Probes tested both vocabulary acquisition and vocabulary generalization and had the same format as the pretests (i.e., multiple-choice sentences, each with four possible answers). As explained previously, each probe used the 32 words composed of four morphographs from the pretest. With an equal distribution of words across the four morphographs, each morphograph was represented on the probe with 2 taught words and 6 generalization words. In addition to items representing the 32 words, nontargeted vocabulary words and sentences were interspersed within the probe, bringing the total to 40. The students could attain a total of 4 correct responses for each condition (8 total) on the taught words and 12 correct responses for each condition (24 total) on the generalization words. The nontargeted items were not included in scores.

Dependent variables. Two dependent variables were measured in this study: acquisition of vocabulary and generalization of vocabulary. *Acquisition of vocabulary* was defined as the number of directly taught words, in each condition, that were correctly selected as answers on a multiple choice probe. *Generalization of vocabulary* was defined as the percentage of novel words, in each condition, that included a morphograph common to the directly taught words. A maximum of two known words per morphograph could be discarded for each participant after the pretest. Based on pretest results, some students correctly selected more than two items per morphograph, causing the number of items possible for acquisition and generalization to change on a participant-by-participant basis for the probe. Therefore, the optimal number of words learned varied by participant when determining cumulative totals. When measuring generalization, percentages were used to account for the variability in possible words. Item-by-item recording was used to measure the number of correct responses of both learned and generalized words on probes given after every two sessions. Answers were scored as correct if the participant circled the answer choice or wrote the letter of the answer choice that appropriately fit the fill-in-the-blank sentence. If the wrong answer choice was circled or recorded, the item was counted as incorrect.

Interscorer reliability. Because the probes were written products, copies of all unscored probes were made so the secondary data collector could independently score answers as correct and incorrect. A second scorer used an answer key to evaluate the accuracy of students' responses on probes. Interscorer reliability was measured by comparing the experimenter's scores and the secondary rater's scores on an item-by-item basis. Answers that were incorrect were marked with an X, and answers that were correct were marked with a C. Interscorer reliability was calculated by counting the number of agreements, dividing by the number of agreements plus disagreements, and multiplying by 100. Interscorer reliability was measured for 30% of the probes; agreement was 100%.

Social validity. Social validity data were collected to measure the outcome of the study from the students' perspectives. Social validity questionnaires concerning the usefulness of whole-word instruction and/or morphograph instruction were used at the end of the study.

Experimental Design

The experimental design was a simultaneous treatments design (Tawney & Gast, 1984) to analyze the comparative effects of whole-word vocabulary instruction and morphographic instruction on students' vocabulary acquisition and generalization. Because the focus of the study was on the acquisition of new vocabulary through the generalization of morphographs, those data were graphed to allow for visual comparison of the effects of two conditions—teaching of whole words and teaching of words with explicit instruction of the morphograph and word. Visual analysis of the graphed data was used to compare treatments. The basic feature of this design is the fast alternation of two different interventions or treatment conditions with an individual learner or group of learners. Specifically, the interventions in this type of design are alternated and counterbalanced within sessions, meaning that students are exposed to both morphograph and whole-word conditions within one session. In a simultaneous treatments design, a functional relationship becomes compelling when there is clear separation between the data paths representing measures of the two dependent variables.

The data for the acquisition of vocabulary are presented in a cumulative graph. Because the number of directly taught words was limited to four per condition per probe, a cumulative graph allows for a visual comparison of trajectories, not evident in a session-by-session representation.

Procedures

General procedures. The experimenter created PowerPoint slides that contained each session's content (e.g., instructions, words, example sentences, clickable icons for audio recordings of the sentences). Figures 1 and 2 show example slides used for peer tutoring for the whole-word and morphograph conditions, respectively.

The study lasted 14 weeks and included tutor training sessions, tutoring sessions, and pretest and probe sessions. Tutoring sessions took place 2 days per week and lasted approximately 7 min for each pair. Following the experimenter's direction to begin, the pairs began tutoring. Although each session was recorded via videotape, the experimenter closely monitored each pair to ensure proper procedures were followed. After every two peer tutoring sessions, a probe was conducted to evaluate the extent to which students had learned the vocabulary words and generalization (untaught) vocabulary words. Prior to the start

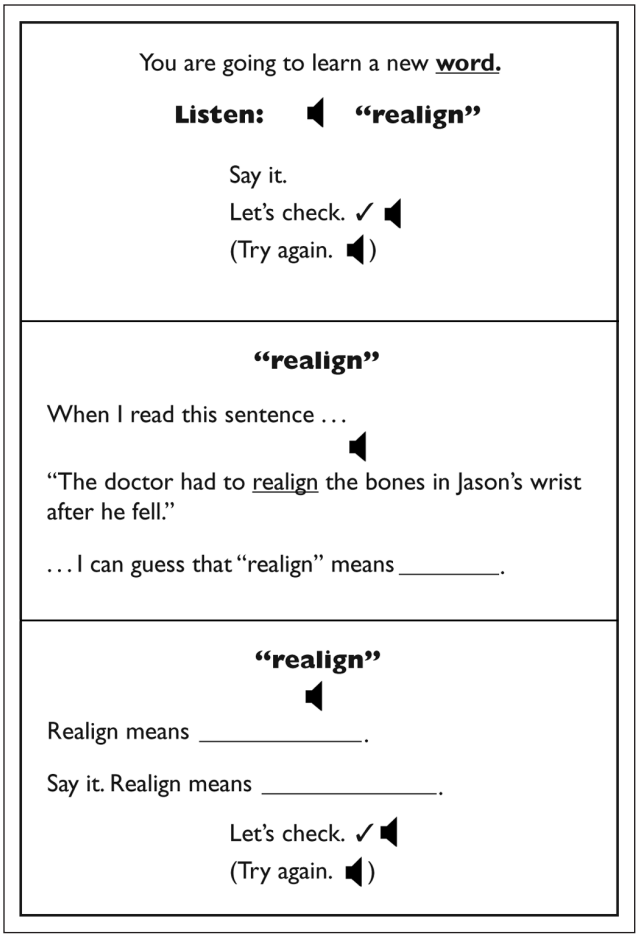

Figure 1. Example slides for computer-assisted peer tutoring during the whole-word condition

of the next set of tutoring sessions, another pretest was used to select unknown words for the next two sessions.

The majority of words used in this study came from lists in workbooks by Draze (2005a, 2005b) and Vurnakes (1998). The word lists were organized by prefixes, suffixes, and word roots. Of the approximately 400 words used in this study, one fourth of these words were directly taught in the tutorial program, with the remaining words used as generalization words during probes. The words were assigned to tutoring pairs so that two pairs of students learned half of the words through morphograph instruction whereas the other two pairs of students learned those words with only whole-word instruction. The reverse took place for the other half of the words.

Tutor training. The experimenter trained all students on the steps of reciprocal peer tutoring (tutoring and feedback) during three 15-min training sessions prior to data collection. All students received step-by-step instructions for the role of tutor and tutee. Specifically, the students were taught appropriate tutoring behaviors (e.g., speaking clearly) as

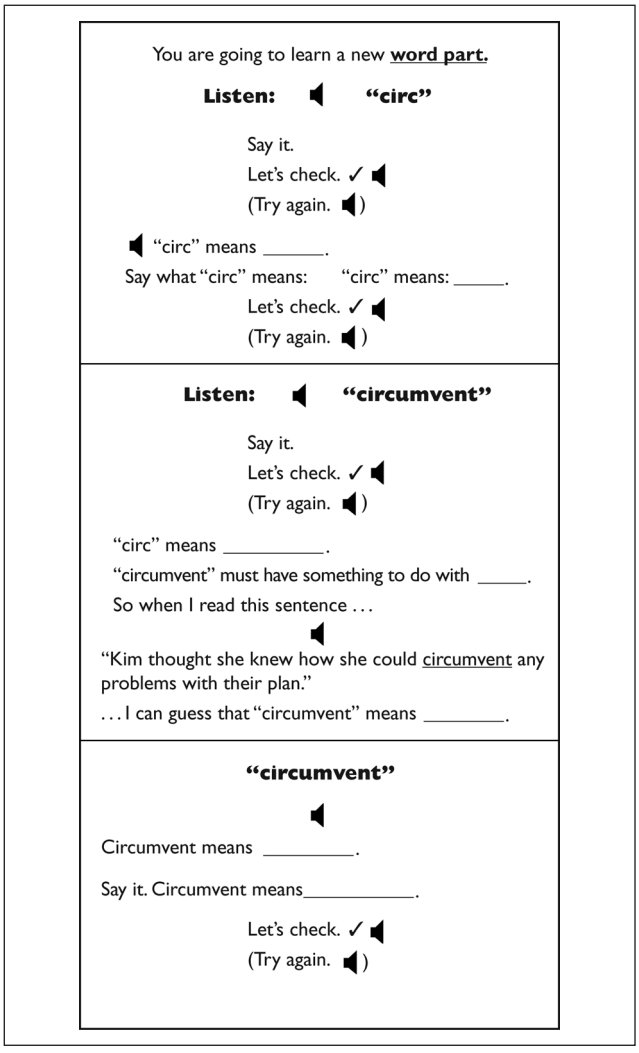

Figure 2. Example slides for computer-assisted peer tutoring during the morphograph condition

well as how to give ample thinking time, praise, or corrective feedback (e.g., "Try again") to tutees. Students received directions on following a script format (blue script for tutor, red script for tutee) in the PowerPoint slides. Tutors were taught to click icons to activate audio recordings of text read aloud and to advance the slides. Data collection began when tutoring pairs demonstrated correct tutoring behaviors and made no procedural errors during the training session.

Pretesting. The experimenter met with the four tutoring pairs in the resource classroom. Prior to beginning the pretests, the experimenter instructed the students to underline any words or word parts they thought they knew and to circle the letter of the best answer choice for each item. The pretest items and answer choices were read aloud by the experimenter. Items were repeated when requested by the students. All pretest sessions lasted approximately 40 min.

Probing. After every second tutoring session, a probe was conducted on all 8 words that the students learned (as both tutor and tutee) as well as the 24 generalization words. The procedures used in pretesting students were repeated for each probe. Of the probes, 40% were recorded for reliability measures. All probes lasted approximately 30 min.

Conditions

The tutoring program was set up so that each student acted as tutor and tutee for a total of four words each session. For each pair, one student in the pair was selected to consistently start the session in the tutor role. In every session, two words with prefixes and two words with roots were introduced. One prefix and one word root were assigned to each condition, representing four morphographs in all. The condition identified to start the session alternated each session and within each session the two conditions alternated as well. For example, one tutoring pair began a session with the first word part being taught using the whole-word condition and the second word being taught using the morphograph condition. The following session, the tutoring program would begin with the morphograph condition followed by the whole-word condition.

Whole-word condition. The whole-word condition introduced an unknown vocabulary word, asked the student to predict the meaning based on the context of a sentence, and then provided the correct definition for the student to repeat. Figure 1 shows example slides for computer-assisted peer tutoring during the whole-word condition.

Morphograph condition. The morphograph condition introduced the meaning of the morphograph and asked the student to repeat the morphograph and its meaning. The student was then given a word containing that same morphograph and was asked to use knowledge of the morphograph (word part) and the context to predict the meaning of the word in a sentence. The correct definition was then provided for the student to repeat. Figure 2 shows example slides for computer-assisted peer tutoring during the morphograph condition.

Procedural reliability. A second observer used a checklist of the procedural steps to obtain reliability. Procedural reliability was calculated as the percentage of steps completed correctly across 30% of the sessions. The mean procedural reliability across sessions was 95%.

Results

Acquisition of Vocabulary

The cumulative number of words acquired for each participant is shown in Figures 3 and 4. For seven of the eight students, the acquisition data path was steeper for words learned

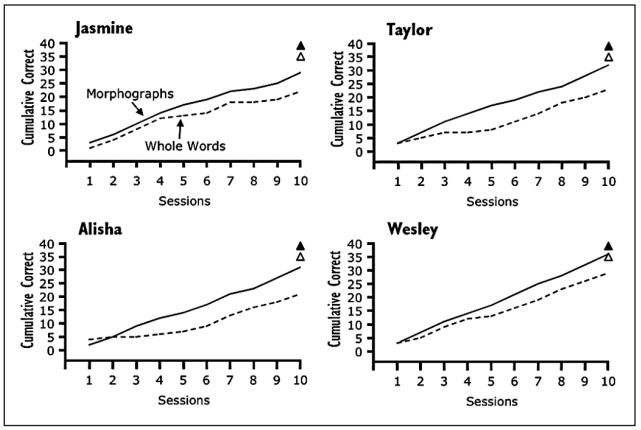

Figure 3. Cumulative words used correctly on probes for Jasmine, Taylor, Alisha, and Wesley
Note: Closed triangles indicate number of optimal words for morphograph condition; open triangles indicate number of optimal words for whole-word condition.

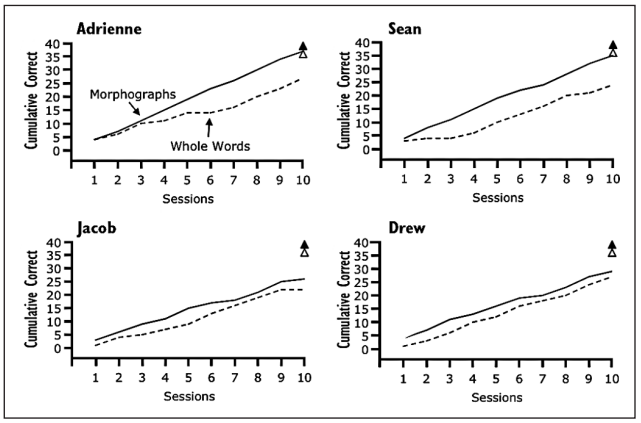

Figure 4. Cumulative words used correctly on probes for Adrienne, Sean, Jacob, and Drew
Note: Closed triangles indicate number of optimal words for morphograph condition; open triangles indicate number of optimal words for whole-word condition.

in the morphograph condition. The number of optimal words students could learn varied by their performance on pretests. The number of optimal words for the morphograph condition is indicated by a closed triangle and the number of optimal words for the whole-word condition is indicated by an open triangle on each student's graph. Students had a mean of 38.5 (range = 35–40) optimal words that could have been learned for the morphograph condition and a mean of 37 (range = 35–40) optimal words that could have been learned for the whole-word condition.

Drew's cumulative total for words acquired in the morphograph condition was 29 of 39 optimal words, compared to 27 of 36 optimal words in the whole-word condition (see Figure 4). When these numbers are used to calculate the

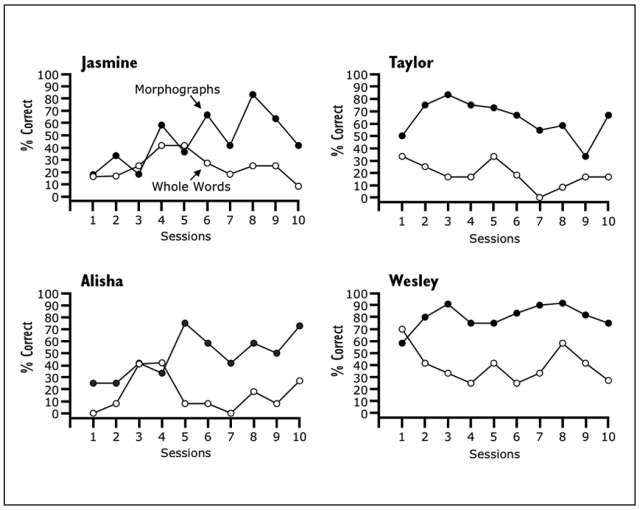

Figure 5. Percentage of generalization words used correctly on probes for Jasmine, Taylor, Alisha, and Wesley

percentage of the optimal number of words that were learned, there is a marginal difference between the two conditions (74.3% in the morphograph condition, 75.0% in the whole-word condition). The percentage difference between the two conditions was greater for the remaining 7 students and favored the morphograph condition. The difference between conditions varies by more than 20 percentage points (range = 25.4%–27.5%, M = 26.9%) in favor of the morphograph condition for Alisha, Adrienne, Sean, and Taylor and greater than 9 percentage points (range = 9.5%–13.3%, M = 10.9%) in favor of the morphograph condition for Jasmine, Wesley, and Jacob. Across students, the mean was 82.9% in the morphograph condition compared to 65.4% in the whole-word condition.

Generalization of Vocabulary

Figures 5 and 6 show percentage correct on generalization words given on each probe for each student in both the morphograph and whole-word conditions. The continuous data paths show that percentage correct on generalization words was higher for all eight students during the morphograph condition when compared to the whole-word condition.

Data paths for Taylor and Adrienne show no overlapping data points or variable trends. Both students' scores were higher during the morphograph condition on all 10 probes. Despite some overlapping data in Probes 3 and 4, Alisha's data show higher percentages in the morphograph condition for the remainder of the probes (see Figure 5). Wesley's data indicate a substantial difference in percentage correct between the two conditions from Probe 2 through Probe 10, in favor of the morphograph condition (see Figure 5). Data for Jasmine and Sean show a higher percentage correct in the morphograph

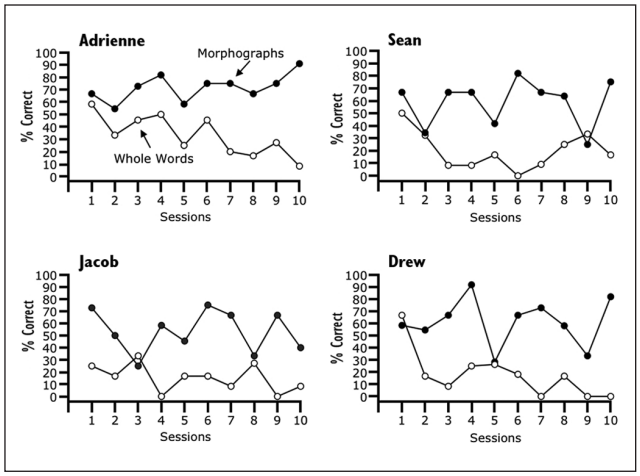

Figure 6. Percentage of generalization words used correctly on probes for Adrienne, Sean, Jacob, and Drew

condition on 8 out of 10 probes. Jacob and Drew's graphs show higher percentage correct on generalization words in the morphograph condition on 9 out of 10 probes.

Social Validity

All students indicated that learning morphographs made it easier for them to learn the meaning of unknown words than when they did not know the morphographs. One student stated, "I enjoyed it very much. I think other students can learn more from this program." All students stated they enjoyed the program when they played the role of tutor. Six out of eight students enjoyed the program when they played the role of learner. Seven out of eight students indicated they would like to use the computer for tutoring again in the future.

Discussion

The purpose of this study was to compare morphograph instruction versus whole-word instruction during computer-assisted peer tutoring. Seven out of eight students acquired more total vocabulary words and a higher percentage of vocabulary in the morphograph condition. One student acquired a higher percentage of vocabulary in the whole-word condition; however, the difference was minimal (i.e., 75.0% vs. 74.3%). This student also had one of the highest reading levels prior to the study and the most developed vocabulary when compared to other students on the pretest scores. Results suggest that teaching the meaning of morphographs that make up target vocabulary words increases acquisition of those words and the generalization of morphograph meaning to novel words increases learning of those words as well because all eight students were better able to generalize to unknown vocabulary when morphograph instruction was added. This study's findings indicate a functional relationship between morphograph instruction and acquisition and generalization of vocabulary.

Based on social validity data, all students indicated that learning morphographs made it easier to learn new words and to decipher the meanings of unknown words in text. Seven out of eight students indicated they would like to use the computer for tutoring again. One participant stated, "I like how the computer talked to us and gave us the right answer. That made it easier to be the tutor." All students enjoyed the program when they played the role of tutor. Taylor stated, "I like being the tutor, because it felt like I was a teacher. It made me feel like I was really helping someone." Only one student indicated that she did not prefer to use the computer for tutoring again and did not offer a specific reasoning as to why.

The findings suggest that teaching vocabulary through morphographs can enhance vocabulary instruction. The results support the findings by Carlisle (2000) and Wysocki and Jenkins (1987). Wysocki and Jenkins specifically focused on morphological generalization with suffixes taught to students in the fourth, sixth, and eighth grades. This study extends that of Wysocki and Jenkins by using different morphographs (i.e., word roots and prefixes). This study also differs from both Carlisle and Wysocki and Jenkins in that the population used in this study was seventh grade students with mild disabilities.

One limitation of this study is that with only four words in each condition there is a relatively low ceiling on how much difference can be seen between the conditions in each session. Another limitation is that the long tests used for pretesting may have resulted in lower scores because of greater fatigue and frustration than with probes. In an attempt to decrease the likelihood of this occurrence, uncomplicated items with easier vocabulary were randomly distributed in the pretests and probes so that students could experience some level of success. Finally, we created all of the probes used in the study; therefore, the technical adequacy of these measures is unknown.

This study has several practical implications for teaching. Results indicate that adding morphograph instruction to more traditional whole-word instruction might increase students' acquisition and generalization of vocabulary more than traditional whole-word instruction alone. Teachers could utilize morphograph instruction as a valuable tool in their classrooms to increase vocabulary acquisition and generalization. Based on the results of this study, teachers should also consider using computer-assisted peer tutoring to supplement teacher-led instruction. As indicated in this study, reciprocal peer tutoring is especially useful for low-performing students or students with disabilities. With embedded audio prompts (e.g., Van Norman & Wood, 2008; Wood, Mackiewicz, Van Norman, & Cooke, 2007), the PowerPoint format ensures

that low-performing students can act as tutor and still be able to provide accurate feedback to the learner.

Depending on the availability of computers in the school setting, a teacher could easily use computer-assisted peer tutoring to provide students with extra vocabulary practice. Teachers could accommodate the whole class by using a computer lab. If a classroom computer is available, teachers could rotate tutoring pairs on and off the computer during the independent work time of a class period.

Extensions of this study could include younger students who are beginning to have reading difficulties so that the vocabulary gap can be narrowed at an earlier age. Researchers could investigate how morphograph instruction assists in the comprehension of longer reading passages. Future studies could use a randomized control group design to compare morphograph instruction with other vocabulary instruction strategies. These studies should use measures of vocabulary or comprehension that have sufficient validity and reliability.

This study offers a promising direction for teaching morphographs to increase acquisition and generalization of vocabulary. At the same time it suggests a number of reasons to be optimistic about using computer-assisted peer tutoring as a resource in teaching vocabulary. Results of this study suggest that students who lack prerequisite knowledge to tutor can be successful when given support through a computer program. Tutoring with a computer can provide a way for teachers to integrate technology into the classroom and allow all students the opportunity to practice appropriate peer social interactions. Students who might not otherwise have the confidence or willingness to participate in whole-class instruction can benefit from brief but intensive practice.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interests with respect to the authorship and/or publication of this article.

Financial Disclosure/Funding

The authors received no financial support for the research and/or authorship of this article.

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