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Effects of morphological instruction on vocabulary acquisition

Peter N. Bowers · John R. Kirby

Abstract The effects of a 20-session intervention targeting morphological word structure on vocabulary knowledge were investigated in four Grade 4 and 5 classes, assigned randomly to treatment and control conditions. Hierarchical regression analyses controlling for initial vocabulary showed significant instructional effects on morphological analysis and vocabulary with words that were taught directly and novel words built on bases that were taught in the context of other derivations, but not for words with untaught bases. Results indicated that the treatment group made better use of pre-test vocabulary knowledge in learning new vocabulary. Results are discussed in light of the growing debate regarding whether to teach many words in a shallow way or to provide deep, rich instruction about fewer words.

Keywords Morphological intervention · Vocabulary development · Spelling · Instructional research

Introduction

The vocabulary children learn during elementary school represents a staggering achievement. Estimates suggest that, on average, children at the end of Grade 2 understand about 6,000 root word meanings, and by the end of Grade 6 about 10,000 (e.g., Anglin, 1993; Biemiller, 2005). Such estimates are far from exact. Quantifying such information is complicated by many factors including varied definitions of what it means to know a word and what counts as a word or word family (Biemiller & Slonim, 2001). Regardless of the exact quantity, it is clear that children learn a great number of words in a relatively short period of time.

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Vocabulary knowledge plays a fundamental role in literacy development and therefore scholastic success (National Reading Panel, 2000). Furthermore, a child's socio-economic status is a critical correlate of vocabulary knowledge (Biemiller, 2005; Hart & Risley, 1995). This dynamic is not hard to understand. The stronger oral vocabulary associated with children of middle and upper classes supports reading success (Biemiller & Slonim, 2001). Successful readers are exposed to more text because they read more, which in turn expands those students' written word vocabulary, thus encouraging still more reading success. All the while, students who begin the process of learning to read with an impoverished vocabulary fall further and further behind their advantaged peers, not only in reading, but in the content areas that depend more and more on independent reading skills (Beck, McKeown, & Kucan, 2002).

A striking feature of the vocabulary learning that children achieve is that it occurs despite the fact that school curricula appear to place little emphasis on explicit vocabulary instruction (Beck, McKeown, & Kucan, 2002). Reacting to conclusions on the state of classroom vocabulary instruction by the National Reading Panel (2000), Biemiller and Boote (2006, p. 44) noted critically, "Current reading instruction is apparently premised on the view that children can build the vocabulary they need after learning to read (decode) fluently, as little or no vocabulary instruction occurs during the primary grades".

Although the National Reading Panel (2000) emphasized vocabulary instruction as a crucial aspect of literacy instruction, it cited lack of sufficient research to recommend any particular strategy over another. Complicating matters for educators who use research to guide their vocabulary instruction, two of the strategies that are commonly cited appear to be in conflict. Biemiller et al. (Biemiller & Slonim, 2001; Biemiller & Boote, 2006) favored what can be characterized as *shallow but wide* direct vocabulary instruction. By contrast, Beck, McKeown and colleagues (e.g., Beck, Perfetti, & McKeown, 1982; Beck, McKeown, & Kucan, 2002; McKeown, Beck, Omanson, & Perfetti, 1983; McKeown, Beck, Omanson, & Pople, 1985) favored what can be characterized as *rich but narrow* vocabulary instruction.

The shallow but wide approach is exemplified by Biemiller and Boote's (2006) recommendation that primary students should be taught about ten words a day with the support of context (e.g., reading a story). To support this approach, they cited intervention studies using brief word explanations to build knowledge of those words (e.g., Biemiller & Boote, 2006; Sénéchal, 1997; Stahl, Richek, & Vandevier, 1991). Studies showing preschool children effectively using narrative-based referents (e.g., Hargrave & Sénéchal, 2000; Sénéchal, 1997) were cited by Biemiller and Boote (2006) as evidence that brief explanations of one or two sentences can be sufficient to establish effective referents for new words. This instruction is consistent with Carey's (1978) "fast mapping" hypothesis that young children use meaning that is illustrated by specific concrete task contexts to "map" (quickly associate) new words with meaning. Carey reasoned that after that initial mapping, learners extend the meanings of words as they encounter them in other contexts. Both Carey (1978) and Biemiller and Boote (2006) stressed that brief explanations of word meanings in context are just the beginning of acquiring word meanings; subsequent exposure is needed.

The contrasting rich but narrow approach (e.g., Beck, McKeown, & Kucan, 2002; Blachowicz & Fisher, 2000) grew from the findings of two reviews of vocabulary instruction (Mezynski, 1983; Stahl & Fairbanks, 1986). This research found that vocabulary instruction influenced comprehension only if it engaged active or deep processing and involved multiple and varied experiences with word meanings. For example, Beck and McKeown (1983) and more recently Blachowicz and Fisher (2000) found evidence that combining the teaching of definitions with other active processing tasks is more effective than instruction that uses definitions alone. Instruction fostering metalinguistic awareness and interest in learning about words, sometimes described as "word consciousness" (e.g., Scott & Nagy, 2004), is a common recommendation in the literature on vocabulary instruction (e.g., Blachowicz, Fisher, & Ogle 2006; Graves & Watts-Taffe, 2002; National Reading Panel, 2000).

Repeated and educationally rich exposure to specific words may bring important benefits, but it cannot directly address the quantity of words that are taught through the shallow but wide approach recommended by Biemiller et al. For example, Beck, Perfetti, and McKeown (1982) and McKeown, Beck, Omanson, and Perfetti (1983) demonstrated that direct instruction in word meanings for 104 words taught over 5 months was effective. While it is important to have evidence that students can learn words that they are taught, this rate of word learning is modest compared to the number of words students need to learn (Anglin, 1993; Nagy & Anderson, 1984; White, Graves, & Slater, 1990). Whether time spent on deeper processing tasks makes up for teaching fewer words is a question that remains for educators and researchers.

Morphology and vocabulary learning

Morphology is widely held to be part of the explanation for how children learn so many words that they were never explicitly taught (e.g., Anglin, 1993; Carlisle & Fleming, 2003; Carlisle, 2007; Nagy & Anderson, 1984; Taft & Kougious, 2004). Anglin (1993) described morphological problem solving as a process by which the meaning of previously unknown complex words can be deciphered. This process involves morphological analysis in which learners break complex words into constituent meaning elements called morphemes (bases, prefixes, and suffixes). A synthesis of the meaning of those component morphemes provides cues to the meaning of a previously unknown word. Nagy and Anderson (1984) estimated that about 60% of the novel words students encounter in texts could be worked out through problem solving morphological structure and their use in a sentence. This metalinguistic process has garnered growing interest in the literature as an important word-learning skill (e.g., Baumann et al., 2002; Henry, 1989, 2003; Nagy, 2005; National Reading Panel, 2000; Scott, 2005; Templeton, 1989, 2004). Wysocki and Jenkins (1987) investigated the extent to which untaught morphological knowledge could account for the increases evident in children's vocabulary that far exceeded the number of words explicitly taught. They found evidence of transfer of word knowledge from taught words to untaught derivations of those words. Anglin (1993) suggested that morphological problem solving is in part responsible for the rapid growth in the knowledge of the meaning of derivations between Grade 3 and 5.

Researchers have begun to investigate the effects of explicit instruction about morphology (e.g., Baumann et al., 2002, Baumann, Edwards, Boland, Olejnik, & Kame'enui, 2003; Carlisle, 2007). Nunes, Bryant, and Olson (2003), Nunes and Bryant (2006), and Henry (1989) provided experimental evidence that morphological instruction improves word reading and spelling, but they also noted that this type of instruction is rare in schools. This omission may have particular relevance for literacy development in English due to the particular nature of oral and written morphology in English.

English has been called a morphophonemic language due to the special interrelationship of its phonology and morphology (Venezky, 1999). It is common for the pronunciation of morphemes to shift across English words. For example, consider the pronunciation of the base *do* in its inflections *does* and *done* or that of *sign* in derivations such as *signal* and *design*. Carlisle (2003a) pointed out that familiar word parts can facilitate language learning compared to learning each complex word in isolation. This, however, can only occur when students recognize morphemes within complex words. In a study with third and fifth grade students, Carlisle (2000) showed that learners are less able to recognize morphological cues in "shift words" that have changes in pronunciation and/or spelling due to suffixing patterns across related forms. Written morphology links large word families with concrete meaning elements via a system of consistent compounding and affixing patterns. It is an empirical question whether explicit instruction about how this system works would help children make better use of relatively transparent connections for independent vocabulary learning. Such instruction could also help children by making it easier for them to recognize morphological cues in shift words. Carlisle (2003b) commented, "Leaving morphological analysis to be discovered by students on their own means that those who are not inherently linguistically savvy are likely to be left behind their peers in the development of vocabulary, word reading and comprehension, and spelling" (p. 312). So far, however, morphology remains a resource of meaning cues that has been poorly exploited by explicit instruction and is only beginning to be investigated experimentally (Nunes & Bryant, 2006; Henry, 2003).

Morphology and vocabulary instruction

Pressley, Disney, and Anderson (2007) reviewed the evidence for the value of teaching internal context cues (morphological word parts) for vocabulary development. Although they described the evidence so far as "thin and equivocal" (Pressley et al., 2007, p 214) they reported that there was some evidence that teaching about morphemes can improve children's and adults' ability to infer the meanings of words.

Graves and Hammond (1980) taught Grade 7 students the meaning of prefixes in the context of one set of vocabulary words. Those students were able to generalize the knowledge to new vocabulary words. The vocabulary intervention by Baumann et al. (2002) incorporated morphology instruction that taught the meaning of eight common prefix families. Morphological instruction produced large immediate effects for deriving the meaning of morphologically decipherable instructed words

compared to a comparison group who received vocabulary instruction about learning words from (non-morphological) context cues, and to a control group, but delayed effects were small. There were no instructional effects on delayed transfer tests. In a follow up intervention, Baumann et al., (2003) used the context of social studies textbook lessons in the classroom to compare the effects of vocabulary instruction which integrated teaching about external context cues and morphological instruction (MC) with the effects of instruction of textbook vocabulary (TV). The morphological instruction in this study focused on 15 prefixes and five suffixes and how to use the meaning of these word parts in conjunction with root words (base words) to learn the meaning of new vocabulary words. MC students were more skilled than TV students at inferring the meanings of morphologically decipherable words on a delayed test but not an immediate test. These studies provide evidence of moderate to small effects on word learning skills through morphological instruction.

Finally, the potential of motivating students to engage in active processing tasks with words through instruction which emphasizes problem solving of word structure cues rather than memorization is another reason for investigating morphological instruction. Focusing on morphology introduces order to the English spelling system, which brings with it the possibility of using problem solving to investigate what Templeton (2004) described as the *vocabulary-spelling connection*. Studying words through one-at-a-time memorization characterizes much of spelling instruction, but it fails to motivate many children to learn about words (Fresch, 2007). Students who begin to understand morphological structure can find ordered spelling and meaning cues in words that morphologically unaware students could only assume are irregular. (e.g., *busy/i + ness → business; do + es → does*). Vocabulary instruction can involve meaning-rich, active processing, and learning experiences without addressing morphology. However, neither the shallow but wide instruction encouraged by researchers such as Biemiller (2004) nor the rich but narrow instruction recommended by others such as Beck, McKeown, & Kucan (2002), offers students the generative spelling knowledge that "provides the basis for explicit awareness and understanding of morphology, which, in turn, may guide the systematic growth of vocabulary knowledge" (Templeton, 2004, p. 120). Such instruction may bring a double benefit of (a) generative word structure knowledge, and (b) motivation to attend closely to words.

The current study

The current study was designed to address the need for word structure knowledge to learn both taught and untaught words, and motivation to use that knowledge, by means of a problem-solving orientation. Teaching students to discover spelling-meaning connections between words via a structured inquiry, problem-solving approach was intended to motivate children to see studying word structure as an interesting, engaging activity in accordance with researchers who encourage the development of "word consciousness" (e.g., Graves, 2006; Nagy & Scott, 2004; National Reading Panel, 2000). Graphic representations of the word structure of morphological families were used to reduce students' working memory load by

presenting the integrated structure and meaning of sets of words instead of presenting those connected words one at a time.

The instructional design of this intervention differs from the studies noted above in terms of (a) the detail of morphological content studied, and (b) how that content was integrated with and dependent on teaching morphological problem-solving. This intervention did not focus on teaching a specific set of prefixes as did Graves (2004), or even a particular set of bases, prefixes, and suffixes like the studies of Baumann et al. (2002, 2003). Instead, this instruction used sets of morphologically related words to teach how to find meaning cues in consistent spelling patterns. Tools such as the word matrix and word sum (described below) were used to investigate morphological word families to guide learning how a relatively small number of meaningful word elements—morphemes—form a large number of words and how these morphemes within complex words can give clues to word meanings. Students were taught about morphological elements, suffixing patterns, and morphological problem solving skills to help them discern morphemes not only in transparent words but also in shift words, in which orthographic shifts due to suffixing patterns or pronunciation shifts might hinder morphological awareness.

The specific research questions investigated were the following:

1. Can Grade 4 and 5 students learn to identify the bases of morphologically complex words as a result of instruction?
2. Does instruction about morphological structure lead to gains in vocabulary learning after controlling for initial vocabulary knowledge?
3. Does ability to identify bases in complex words explain variance in vocabulary knowledge for both the control and experimental groups at post-test?

Method

Participants

The participants were 81 children in two Grade 4 classes and two Grade 5 classes from two public Catholic schools in and around the area of Kingston, Ontario. One school was in a suburban neighborhood and the second was in a nearby small town. Classes were randomly assigned to the experimental ($n = 38$; average age = 10 years, 2 months) and control ($n = 43$; average age = 10 years, 1 month) conditions with the constraints that each condition included one Grade 4 and one Grade 5 class, and each had a class from each school. Data from students designated by the school as having a learning disability, language impairment, or autism were excluded from the analysis.

Of the 110 students in the four classes, 94 returned signed permission forms (85%). Of these, one student moved before post-test and nine were dropped from the analysis due to being designated by the school as having a learning disability, language impairment, or autism. Finally, incomplete data for three participants left a final sample size of 81. Although only students with signed permission forms

participated in the testing, all students in the experimental classes participated in the intervention lessons, which teachers treated as a part of the core literacy curriculum.

This study reports specifically on data concerning written morphological knowledge and vocabulary learning. Other pretest and posttest measures were administered in conjunction with the study. Only the testing related to the data analyses presented in this study is described here.

Measures

Pre-test measure

Prior to instruction, all participants were administered the Peabody Picture Vocabulary Test III (PPVT-III) (Dunn & Dunn, 1997), a test of receptive vocabulary knowledge. In this task, a vocabulary word is presented orally to the child who is asked to point to one of four pictures that best represents the meaning of the word. Two practice pages were used to make sure children understood the task. The maximum number of items on the test is 204, but the highest item a participant reached was 192. The score was the total number of correct responses. The alternative forms reliability coefficient reported in the manual for this task is .91 for 10-year-olds. Three trained testers (including the first author) assessed participants from the four classes during the same time period. The test was administered individually during the regular class time in a quiet room at the participant's school. The assignment of classes to control and experimental conditions occurred after pre-testing so that testers did not know which students would be in the experimental group.

Post-test measures

Two measures were constructed based on the words included in the intervention program, Base Identification and Morphological Vocabulary. The two measures were linked in that after each item in Base Identification the participant was asked to define the word. Both tests used the same set of 30 words, which were divided into three groups: Word Taught, Base Taught, and Affix Taught (all words are shown in the Appendix). A trained research assistant, who was blind to the status of students as control or experimental group members, conducted the testing. We first describe the two measures, then the three groups of words.

Base identification This individually administered task assessed participants' ability to identify the base in multi-morphemic words. The test was introduced as an activity called "Circle the Main Part of the Word". The participant was shown how to do the task with the help of a practice set of words for which the tester could clarify incorrect, good, and better responses. The practice words were *books, making, running, enjoyment*, and *bookstore*. Whether their initial response was correct or not, the tester made sure that the student saw the correct answer. For example, for *making*, the tester noted that the *e* of the word *make* (the "real" main part of the word) was missing, so the best they could do was to circle the letters *mak*.

For *running*, it was indicated they should only circle *run*, because the main part of *running* was *run*, which only had one *n.* Whether the student circled *enjoy*, or *joy*, for *enjoyment*, the tester made it clear that either was good, but that *joy* was the best answer because it was the smallest main part of the word. For the compound *bookstore*, participants were told that they could circle both *book* and *store*, because they were both main parts of the word.

The test consisted of 30 words which were presented in a booklet arranged in a single column down the center of each page. Each participant was allowed as much time as desired to complete the test and no feedback was provided. Each item was scored on a 3-point scale using the following criteria: (a) 2 points were awarded for circling the base (either a real word or a bound base) or the smallest stem that could stand on its own as a word (a stem is a base with at least one affix); (b) 1 point was awarded for circling any part of a word that removed at least one affix, but failed to reduce the stimulus word to the smallest stem that could stand on its own as a word; and (c) 0 points were given for circling part of a stimulus word that was neither a base nor a stem. The scoring system was designed to avoid awarding points for knowledge of linguistic features that only students with explicit instruction (i.e., those in the experimental group) could be reasonably expected to have. For example, for the word *victoriously,* circling the stem *victor* (*vict* + *or*) or circling the bound base *vict* for 'conquer' each earned 2 points. Only the experimental group had been taught that a base does not have to be a word on its own. Circling *victori* (representing victory), or *victorious* each scored 1 point as they both represent real word stems of the target word *victoriously*. The Cronbach alpha reliability of this test was 0.88.

Morphological vocabulary This measure assessed the ability of participants to explain the meaning of the words used for the Base Identification task. After completing the practice words for Base Identification, the tester said, "After you circle the main part of a word, I'm going to ask you to try to give a short description of the meaning of the word". When the participant finished circling, the tester asked, "Could you tell me what that word means?" If the participant gave no answer, or the answer was unclear, the tester used these prompts: "Can you add any more detail?" and, "Can you use that word in a sentence?" The tester recorded the exact wording used by the student.

A 3-point scale was used for each item to distinguish among no understanding, a limited understanding, and a more fully realized understanding of the meaning of a word. The scoring criteria were as follows: (1) two points were awarded for responses that showed a clear understanding of the target word, including base or stem and affixes, either by providing a definition, or by using the target word correctly in a sentence. (2) One point was given to responses that either (a) gave a vague sense of the meaning of the word by using it in a sentence, or (b) gave the meaning of one of the main morphemes (e.g., the *produce* or the *re* of *reproduce*), or (c) gave a vague sense of the meaning of one of the main morphemes by using it in a sentence. (3) Zero points were given if participants gave no response or if their answer was not connected to the meaning of target word. Two raters scored the definitions of 10 randomly selected tests with the scoring criteria set out below. Inter-rater agreement was 95%, so the remaining tests were scored by the first

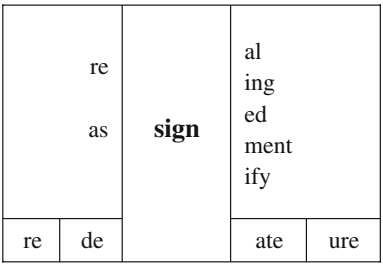

Fig. 1 A word matrix on the word *sign*

author; test papers were put in random order so that the scorer could not determine group membership. Any uncertainties were resolved through discussion. The Cronbach alpha reliability estimate for this measure was also 0.88.

Selection of words The words used in these measures were selected specifically with respect to the words taught in the intervention to assess the effect of instruction along a continuum of near, to mid, to far transfer. The 30 words were divided equally among three groups and presented in mixed order.

The words in the first group were termed *Word Taught*. Inclusion criteria for this near transfer category were that the instructor had addressed it explicitly in class and/or that exact word had been included on one of the children's written assignments. If a word appeared on a page handed out to the children, if it was on an overhead, or posted in the classroom, it was considered to be in the *Word Taught* category. This included words that were not presented in full form, but could have been created by the student from a word matrix presented by the teacher (see Fig. 1 for an example of a word matrix). The intervention used a total of 20 matrices; representing 196 words fitting the *Word Taught* criteria. Activities that did not include a matrix but presented words for creating word sums presented children with 234 more words. Thus a total of 430 words met the criteria of *Word Taught*. Ten of those words were used as Word Taught Words during testing.

The words in the second group were *Base Taught* words, whose bases and affixes had been taught explicitly during lessons, but never in the specific derivational or inflectional form used on the test. This category represented a level of transfer beyond *Word Taught* words. To demonstrate a gain from instruction on these words, students would have to apply knowledge of bases, affixes, and perhaps suffixing patterns to words that were not explicitly taught.

The words in the third group were *Affix Taught* words. These words used bases that were not taught during the intervention. Students would have encountered the affixes in these words during instruction, but only in combination with other bases. Because the base is the morpheme that carries the core meaning of a word, this category of word represents the farthest level of transfer of the three word groups.

Instruction

While the control group classes continued with typical instruction, the experimental classes participated in three or four 50-min lessons each week taught by the first

author until 20 sessions were completed. Instruction took place in the regular classroom with the classroom teacher present and participating in the sessions.

Content

The instruction was designed to convey the following key terms and concepts about morphology and orthography:

1. English spelling is a highly consistent system for representing the meaning of words. Few words fail to follow established conventions for this purpose.
2. Morphemes (bases, prefixes, and suffixes) are the smallest units in a word that carry meaning. Morphemes can be combined and recombined to form many words like Lego pieces are rearranged into countless structures.
3. Bases, prefixes, and suffixes maintain consistent spellings in words regardless of shifts in pronunciation. Spelling changes occur across derivations according to consistent suffixing patterns.
4. Compounding and three consistent suffixing patterns were taught: (a) replacing the single, silent *e,* (b) doubling single, final consonants, and (c) *y/i* changes.
5. The base carries the core meaning of a word, which is then modified by the affixes with which it is combined. A base that can stand on its own as a word is called a free base (e.g., *run*). There are bases that never stand on their own as words, called bound bases (e.g., *struct* denoting *build*).
6. Twin bases are two forms of the same base that carry the same core meaning in the morphological family of words they build. For example, the twin bound base *duce/duct* for 'lead, bring' are the foundation for all the derivations built on both *product* (*pro* + *duct*) and *produce* (*pro* + *duce*) or words that do not include these stems such as *educate* (*e* + *duce*/+ *ate*) or *deduce* (*de* + *duce*).

Process

The experimental program was labeled "structured word inquiry" to describe its underlying philosophy of instruction. A guided problem-solving approach was used to investigate how word structure provides cues to meaning. Students were asked to act as "spelling detectives" to investigate sets of words chosen to reveal a targeted spelling pattern. For example, the first lesson was designed to introduce the building block structure of written morphemes despite pronunciation shifts. Students were challenged to use the morphological matrix for *sign* (Fig. 1) to investigate the question "Why is there a *g* in *sign*?" From that matrix words like *signal*, *assignment* and *signature* were built with word sums (*sign* + *al; as* + *sign* + *ment; sign* + *ate/* + *ure*) to show how morphemes are assembled like pieces of Lego to form complex words. The teacher (first author) used an overhead projector to share discoveries and guide students' understanding of the principle that the spelling of these word parts, called bases, prefixes, and suffixes, remain the same across words even if pronunciation shifts. Each new concept (e.g., suffixing pattern for the single, silent *e*) was introduced with a starter question that could be resolved by investigating patterns in selected sets of words. In this way, it was hoped that students would gain

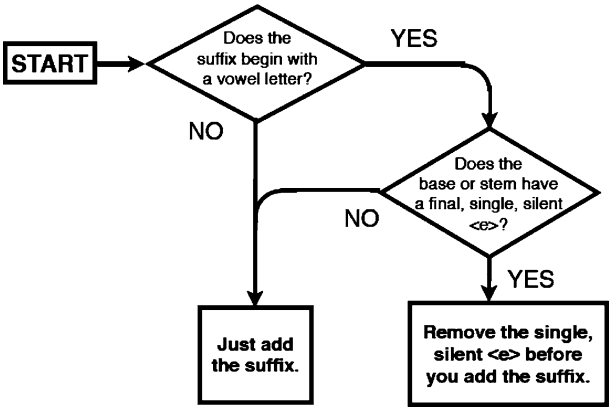

Fig. 2 Flow chart of pattern for suffixing pattern for dropping the single, silent *e* (Ramsden, 2001, p. 17). *Reprinted with permission of author*

not only the word structure knowledge targeted by the lessons but also metalinguistic problem-solving strategies that could be used independently on novel words.

Over the course of 20 lessons, a consistent process of instruction was employed to help students develop and test hypotheses about increasingly complex orthographic patterns. The basic structure of the instruction was as follows:

1. Present an interesting spelling problem that highlights a core orthographic element, pattern or principle.
2. Present students with sets of words selected to reveal the pattern that is the focus of the lesson. Encourage the development of hypotheses for the class to test.
3. Test hypotheses in order to confirm and describe exact orthographic pattern.
4. Provide systematic practice of newly learned patterns with a set of words chosen to reinforce a given pattern. (Fig. 2 provides an example of a flow chart used to practice suffixing patterns after students had identified them through structured inquiry.)
5. Identify spelling questions in preparation for the next investigation.

Instructional activities were of three types: (a), exploratory problem-solving (hypothesis development), (b) focused problem-solving (hypothesis testing/confirmation), and (c) structured practice of newly learned content. Instructional time was divided roughly equally between activities that emphasized problem solving and those that emphasized practicing newly learned concepts. Instruction was designed to shift regularly between practice and problem solving in an attempt to maintain the interest of students, while also giving systematic practice of the orthographic principles being taught. Worksheets were used over the course of the intervention that included prepared matrices, sets of words, and word sums selected to target particular patterns. Put together these lessons presented children with 430 words meeting the criteria of Word Taught. Thus in this study, words that were considered to have received direct instruction received much less attention compared to

vocabulary interventions such as those of Beck et al. (1982) or Baumann et al. (2002, 2003).

The orthographic and morphological knowledge that grew through this process was intended to encourage independent thinking about orthographic patterns, and knowledge about how to use resources to test those hypotheses. Reference works including typical dictionaries and word origin dictionaries became regular tools in investigations, and were used to confirm students' morphological hypotheses. Lessons used word matrices (Ramsden, 2001) and word sums to support instruction about morphological structure with concrete representations that could be interrogated in a full class lesson. Multiple sensory channels as suggested by Mousavi, Low, and Sweller (1995) were used. For example, students were taught to spell out word sums both in writing and orally to emphasize morphemic and graphemic units. Thus the word sum *please/+ ure → pleasure* was modeled on an overhead transparency as the class and teacher simultaneously wrote and spoke out loud, "p–l–e-a–s–e–*plus*-u-r-e-*is rewritten as*-p–l–e-a–s–*no e*—u-r-e". The dash length represents pause length between saying letter names. For this word sum, a long pause indicates the morphemic boundary between the base and the suffix. The letter names in of the *ea* string are named together quickly to highlight its structure as a digraph. Students were also explicitly taught to use a finger to follow the path of questions on the flow chart (Fig. 2) for suffixing patterns while reading the relevant questions for suffixing as a way of reinforcing a regular sequence of questions to pose when investigating the structure of complex words. These tools were also intended to motivate active participation in word structure activities by offering an entertaining way to focus students' attention directly to the content of the intervention. Put together, all these tools supported an instructional approach targeting the development of students' word consciousness (Scott & Nagy, 2004).

Results

Means and standard deviations for all pre- and post-test measures are presented in Table 1. The only pre-test measure was PPVT-III. Means and standard deviations for scores on this measure showed that the control and experimental groups were not significantly different in vocabularly knowledge at pre-test $t(79) = 1.29$, $p = .20$. These raw PPVT-III scores are in the average range for students of 10 years, 2 months.

Table 2 presents correlations between all measures.

Raw scores within each level of Base Identification and Morphological Vocabulary were transformed into z-scores. A 2 (group: experimental versus control) × 3 (Level of Transfer: near, medium, and far) ANCOVA was performed, with repeated measures on the second factor represented by the three types of words (Word Taught, Base Taught, and Affix Taught, respectively), for each of the outcome measures (Base Identification and Morphological Vocabulary). The covariate in each analysis was pretest vocabulary (PPVT-III), to control for the small but nonsignificant differences on the pretest.

Table 1 Means and standard deviations for control and experimental groups on all measures

Measure	Control			Experimental		
	n	Mean	SD	*n*	Mean	SD
PPVT-III (raw scores)	43	134.88	14.72	38	130.50	15.75
Morph. vocabulary word taught	43	8.84	3.89	38	10.50	4.43
Morph. vocabulary base taught	43	5.75	2.61	38	6.76	3.65
Morph. vocabulary affix taught	43	10.63	3.95	38	9.55	5.32
Base identification word taught	43	9.47	2.07	38	13.79	4.20
Base identification base taught	43	12.91	2.98	38	16.76	3.90
Base identification affix taught	43	9.95	2.53	38	12.13	3.29

Table 2 Correlations between pre-test vocabulary (PPVT-III) and outcome measures for control group ($N = 43$) above diagonal and experimental group ($N = 38$) below diagonal

	1	2	3	4	5	6	7
1. PPVT-III	–	.331*	.195	.261	.475***	.257	.382*
2. Base identification word taught	.165	–	.165	.218	.204	.119	.178
3. Base identification base taught	.153	.716***	–	.389**	.431**	.491***	.473***
4. Base identification affix taught	.165	.624***	.779***	–	.382*	.367*	.363*
5. Morphological vocabulary word taught	.669***	.424**	.369*	.440**	–	.636***	.662***
6. Morphological vocabulary base taught	.634***	.284	.249	.374*	.752***	–	.713***
7. Morphological vocabulary affix taught	.500***	.412**	.414**	.521**	.754***	.816***	–

Note: PPVT-III, Peabody picture vocabulary-III (Dunn & Dunn, 1997)

*** $p \leq 0.001$, ** $p \leq 0.01$, * $p \leq 0.05$ (all 2-tailed tests)

Base identification

For Base Identification, the covariate was found to have a significant effect, $F(1,78) = 4.57$, $p < .05$, $\eta_p^2 = .06$. There was also a significant effect of Group, $F(1,78) = 36.53$, $p < .001$, $\eta_p^2 = .32$ indicating that the experimental group outperformed the control group. The linear component of the interaction term (group × level of transfer) was marginally significant $F(2,156) = 3.87$, $p = .053$, $\eta_p^2 = .05$. A graph of this interaction is shown in Fig. 3.

To explore the interaction, tests of between-subjects effects for each level of transfer were conducted to assess the effect of instruction with pretest vocabulary as a covariate. The covariate effect was not significant for any level of transfer. For each level of transfer, the group effect was significant, for the near transfer measure, Word Taught, $F(1, 78) = 39.49$, $p < .001$, $\eta_p^2 = 34$, for the mid transfer measure, Base Taught, $F(1, 78) = 28.02$, $p < .001$, $\eta_p^2 = 26$, and for the far

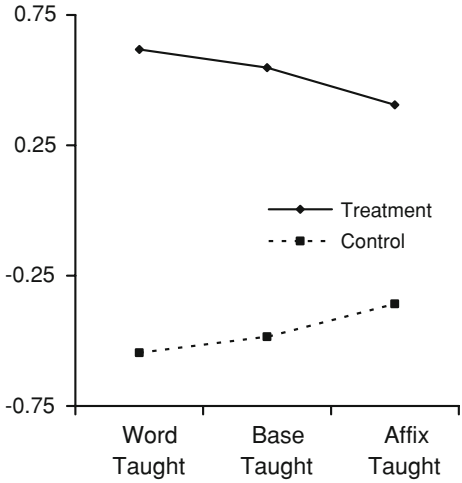

Fig. 3 Base Identification *z*-scores for experimental and control groups after controlling initial vocabulary

transfer measure Affix Taught, $F(1, 78) = 13.33$, $p < .001$, $\eta_p^2 = 15$. Inspection of the graph shown in Fig. 3 indicates the source of the marginally significant interaction between Group and Level of transfer was that the difference between the groups decreased with greater degree of transfer assessed, as is suggested by the strength of the individual between groups effects.

Morphological vocabulary

The same repeated measures ANCOVA, 2 Group × 3 Level of Transfer, with PPVT-III as the covariate, was conducted with the Morphological Vocabulary scores as the dependent measure. The covariate of initial vocabulary was significant, $F(1,79) = 30.81$, $p < .001$, $\eta_p^2 = .28$ as was the effect of group, $F(1,79) = 3.99$, $p < .05$, $\eta_p^2 = 05$. The linear component of the group × level of transfer interaction was significant, $F(2,158) = 15.36$, $p < .001$, $\eta_p^2 = .16$. A graph of this interaction is presented in Fig. 4.

To investigate the interaction, the two groups were compared at each level of transfer, again using pretest vocabulary as a covariate. The covariate was significant for each level of transfer: for the near transfer measure, Word Taught, $F(1, 79) = 35.6$, $p < .001$, $\eta_p^2 = .31$; for the mid-transfer measure Base Taught, $F(1,79) = 20.2$, $p < .001$, $\eta_p^2 = .20$, and for the far transfer measure Affix Taught, $F(1, 79) = 18.86$, $p < .001$, $\eta_p^2 = .19$. The experimental and control groups differed on the near transfer Word Taught measure, $F(1, 79) = 10.4$, $p < .01$, $\eta_p^2 = .12$, and on the mid-transfer measure Base Taught, $F(1, 79) = 6.01$, $p < .05$, $\eta_p^2 = .07$. These results clearly indicate that morphological instruction helped the students define words when either the base or the whole word had been taught, but not when only the affix had been taught.

Finally, regression analyses were conducted to investigate whether being able to identify the bases of words (defined by their Base Identification scores) helped the students define those words (as indexed by their Morphological Vocabulary scores).

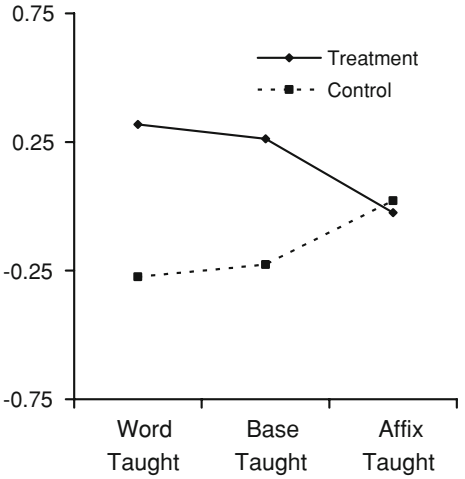

Fig. 4 Base Identification *z*-scores for experimental and control groups after controlling initial vocabulary. Morphological Vocabulary z-scores for experimental and control groups after controlling initial vocabulary

Table 3 Results of hierarchical regression analysis predicting morphological vocabulary from base identification on after controlling for initial vocabulary (PPVT-III) for control and experimental groups

Dependent variable total vocabulary outcome				
Model	Control ($N = 43$)		Experimental ($N = 38$)	
	β	ΔR^2	β	ΔR^2
1. PPVT-III	.437	.191**	.666	.443***
2. Base ID	.383	.128**	.348	.117**

Note: β shown for the step at which its variable is entered in the model

*** $p \leq 0.001$

** $p \leq 0.01$

Separate analyses were conducted for the control and experimental groups; pretest vocabulary (PPVT-III) was entered in the first step of the model, and the total score on the Base Identification measure was entered in the second. Table 3 shows that for both control and experimental groups, initial vocabulary knowledge explained significant variance in the Morphological Vocabulary measure (19.1% for the control group, and 44.3% for the experimental group). After controlling for this effect, scores on the Base Identification task explained 12.8% of the variance in scores on the post-test vocabulary measure for control students and 11.7% for the experimental students.

Discussion

The current study tested an approach to teaching vocabulary that attempted to address a variety of criteria identified by the National Reading Panel (2000) and

others (e.g., Pressley, Disney, & Anderson 2007) as important to effective vocabulary instruction. Evidence that teaching part of a morphological family transferred to words in that family that were not taught, would address the concerns emphasized by Biemiller (2005) and others regarding the quantity of vocabulary that students need to learn. By capitalizing on well-ordered morphological spelling patterns, a problem-solving "structured word inquiry" approach was intended to provide the deeper processing of words during vocabulary instruction called for by other researchers (e.g., Beck, McKeown, & Kucan 2002). Using this instruction, we aimed to build both students' generative word knowledge and their motivation for understanding words—their word consciousness that Nagy and Scott (2004, p. 201) described as "the knowledge and dispositions necessary for students to learn, appreciate, and effectively use words". We begin by summarizing the evidence regarding each of the research questions, and then turn to discussion of the implications.

The first research question addressed whether students learn to identify the bases of morphologically complex words as a result of the instruction. If targeting the morphology system as a tool for generative word knowledge for elementary students is to be successful, it must be established that these children master morphological linguistic content that they would not master as a result of typical classroom instruction. The Base Identification results were clear. After controlling for initial vocabulary, the instructional group was significantly better at identifying the base of complex words for each level of transfer.

The second research question was whether instruction about morphological structure would lead to gains in vocabulary learning. After controlling for the significant correlation between initial vocabulary and Morphological Vocabulary, instruction had an effect on the near and mid transfer measures of Morphological Vocabulary. Instruction did not have any effect for the far transfer vocabulary words—those words outside of the morphological families that were taught.

The third research question asked whether ability to identify bases in complex words would predict vocabulary knowledge. Whether or not students received direct instruction about morphology, their ability to identify the base in complex words contributed a significant amount of variance to their knowledge of the words in the Morphological Vocabulary measure.

This study provides evidence that a 20-lesson classroom intervention for Grade 4 and 5 students can teach morphological analysis knowledge and skills that provide them with a means to develop vocabulary beyond the words they are taught, but not beyond the morphological families that they are taught. It would have been good news if this instruction had improved students' ability to define words from untaught morphological families, but that hope may well be too high, at least for a 20-session intervention. Because the base carries the core meaning of a word, unless students are already familiar with the meaning of a base—by instruction or by incidental learning—morphological analysis cannot provide the learner with access to the meaning of a word.

The results for Base Identification showed that teaching Grade 4 and 5 students how morphology works improved their ability to peel affixes off complex words. Students can be taught to identify the bases of novel words, but that skill in and of

itself cannot provide a student with knowledge of the meaning of novel bases. Being taught morphological analysis skills may, however, make it easier for students to recognize a base they know in large complex words that could be missed without the scaffolding of word structure knowledge gained through instruction. Suggestive evidence that this may have occurred is found in the much greater contributions of initial vocabulary knowledge (PPVT) to variance in morphological vocabulary for the experimental group (41.6%) than the control group (15.1%), with similar contributions of the ability to identify the base for both groups. Because the experimental group had higher Morphological Vocabulary scores than the control group despite their initially similar PPVT scores, the differing contribution of that PPVT knowledge to morphological vocabulary suggests that morphological instruction may have helped the experimental students apply their initial vocabulary knowledge to the task of describing word meanings. These results are consistent with the idea that when faced with an unfamiliar word, a more skilled morphological problem-solver is better able to recognize a meaningful link to a related familiar word. A part of the benefit may come from simply knowing that there are often meaningful links to look for. "It is only when students believe they know how to analyze unfamiliar words in texts that they will expend the energy to become close readers" (Carlisle, 2007, p. 99).

A hypothetical scenario of morphological analysis that mirrors the kind of investigations that occurred during the intervention is offered as speculation about how taught morphological awareness might support students in their more effective use of initial vocabulary knowledge. Faced with a word like *condensation*, students in the control group who happen to know the base *dense* might fail to recognize that familiar base within this complex word due to a slight phonological shift and the spelling change between the target word and its base. Students in the experimental group with the same initial vocabulary knowledge could plausibly discover this base that they knew, but did not immediately recognize, by the application of morphological knowledge gained through instruction and practice. An ability to mentally peel off the familiar *con-* prefix and the *-ate* and *-ion* suffixes may increase the salience of the *dens* letter string as a possible marker for the word *dense* that they have in their lexicon. If that *dens* orthographic string activates students' knowledge of the word *dense* with the meaning of 'tightly packed together', the semantic link between this base and the scientific term *condensation* could help them form a hypothesis. It may be that the experimental group's greater Morphological Vocabulary knowledge was achieved by giving students technical skills to help them capitalize on mutually reinforcing meaning cues across derivations that lie dormant in untaught students.

The consistent structure of written morphology facilitates the use of problem-solving activities in which learners act as "word detectives". The literature emphasizes the importance of vocabulary instruction that motivates children to enjoy and actively engage in the study of words and their meanings (e.g., National Reading Panel, 2000). Motivating students with engaging word study was a key element in the design of the instruction. A limitation of this study, however, is that it can only provide anecdotal evidence on this aspect of the instruction. The instructor/first author observed that there were clear signs of high interest for studying the

content for many of the students in the experimental group. For example, several opportunities for independent word inquiries were well used. Students frequently submitted written questions about the spelling of words, regularly added hypotheses about prefixes and suffixes to the class affix chart, and posed oral questions in class. Although these were voluntary assignments with no grade attached, students were told that to have their inquiries addressed, they needed to write their theory of the word sum related to their question. The keen response to this extra work is akin to what Beck, McKeown, and Kucan (2002) reported with their "Word Wizards" activity that resulted in students bombarding them with questions about words.

Students from both intervention classes consulted dictionaries frequently to test orthographic hypotheses independently. Students expressed a preference for the larger dictionaries over "student dictionaries", because they included word origin information that helped them test hypotheses of morphological connections. They also made use of two etymological references, a large Word Origin Dictionary (Ayto, 1993) and a dictionary called "Word Stems" (Kennedy, 1890/1996).

Perhaps the most convincing evidence that this instruction was received with enthusiasm by students and teachers is that after the intervention, with great effort by the teachers and special education teachers who had students in classes of the experimental group, funds were secured to buy the Real Spelling materials (Ramsden, 2001) upon which this instruction was based. Since the intervention, teachers in both schools who were involved in the intervention—and teachers who were not—continued to integrate this instruction into their teaching.

Vocabulary instruction that is deep and wide

At the outset of this paper, we pointed to an apparent conflict between two strategies for vocabulary instruction recommended by the literature (e.g., National Reading panel, 2000; Pressley, Disney, & Anderson 2007). We characterized the strategy of Biemiller et al. (Biemiller & Slonim, 2001; Biemiller & Boote, 2006) as the wide but shallow approach because it favors direct teaching of many words at the expense of rich, repeated instruction of words. In contrast we described the strategy favored by Beck, McKeown, and Kucan (2002) and others, as deep but narrow because, at the expense of direct instruction of many words, it recommends repeated rich instruction aimed at developing not only a deep understanding of the words taught, but also a generative interest and engagement with the study of words. The current study provides evidence that morphological structure may provide a way to address both of these seemingly incompatible strategies, while simultaneously meeting another goal identified in the vocabulary research—teaching word-learning strategies.

The role of the word matrix (Ramsden, 2001) may help clarify how all these goals can be addressed simultaneously. When a matrix was used, instruction did not give each possible derivation or inflection equal attention. For example, of the 18 words represented by the *sign* matrix (Fig. 1), 3 were selected for close attention, 7 received brief explicit attention, and some were not explicitly addressed by the teacher at all. The words *signal* and *assignment* received special attention as they were used for examples of building word sums from the matrix. They were also used to illustrate that the semantic distance of a derivation from its base can be small

(*signal*) or relatively large (*assignment*), and that the pronunciation of a base can change dramatically or not at all in related words. The word *signature* was used as another example of a phonological shift across related words, but this word received particular attention as the word used to introduce the investigation of suffixing patterns for single, silent *e*. Another subset of seven words (*sign, signed, signing, design, redesign, assign*, and *signify*) was explicitly targeted to practice the interconnection of structure and meaning of morphologically related words, but only received brief explanations of meaning when necessary. Although the word *designate* is represented by the matrix, and may have been identified independently by some students, it did not receive explicit whole class instruction. This instruction offered learners the rich active processing recommended by Beck et al. (2002) for 3 of the 18 words for the *sign* family while providing quick exposure to a larger number of words with the benefit of a structure and meaning referent to help 'map' new word meanings as recommended by Biemiller and Boote (2006). Evidence of vocabulary learning was found not only for words that received rich or brief attention, but also for untaught relatives of taught words. These results suggest that it may be productive to reframe the question of how many *words* vocabulary instruction should target as a question of how many *morphological families* should be taught. Teaching many base words with attention to the application of morphological principles should improve vocabulary significantly, and potentially affect reading comprehension.

The word matrix provides the lynchpin that makes it possible to bring these elements together into one instructional design. It provides a concrete, visual representation of morphological structure linking large families of words regardless of pronunciation via the consistent spelling of morphemes. Word sums then provide a practical tool for problem-solving and practicing the consistent suffixing patterns that clarify how those morphemes combine into the completed spelling of a word. The matrix and the word sum help students focus directly on the coherent, reliable patterns that drive how the English spelling system represents meaning.

The nature of the integration of meaning and structure in morphological families and the use of the matrix and word sums to focus learners' attention directly on how that structure works, provide ground for suggesting links to Perfetti's lexical quality hypothesis (Perfetti, 2007). He posited that the quality of the mental representations of words affects the ease with which a person gains access to a word. Lexical quality is defined by the extent to which a mental representation specifies its form (orthographic and phonological) and meaning components. Perfetti presented five features of lexical representation that determine lexical quality. The first four, *orthography*, *phonology*, *grammar*, and *meaning*, are constituents of word identity, and the fifth, *constituent binding*, "…is not independent but rather a consequence of the orthographic, phonological and semantic constituents becoming well specified in association with another constituent" (pp. 360–361). It seems plausible that morphological knowledge acts as a constituent binding agent—a kind of "lexical representation glue" which contributes to and strengthens knowledge of word meanings including grammatical knowledge carried by suffixes. By means of various lexical features, morphological knowledge provides a stronger binding force for words of a morphological family, but less so for unrelated words, because the

core meaning of a complex word is carried by its base. If this were the case, increasing precise morphological knowledge would support the development of high quality lexical representations, not just for words, but for families of structurally and meaningfully related words. The word matrix—a schematic diagram of the integrated structure of a morphological word family—provides a tool to draw students' attention to the various features of word identity and how they bind together.

Limitations and suggestions for future research

One limitation of the instruction in the study may have been an overemphasis on the mechanics of the morphological spelling patterns and too little emphasis on explicit modeling of how to use these skills to infer the meanings of complex words. Learning how words are built is a crucial step in learning how to find meaning cues in words, but more time could have been used to teach how to use that knowledge to infer meaning. Ironically, despite the positive vocabulary results, this intervention used little direct practice of word meanings as is standard in vocabulary interventions.

Another important limitation of the study was lack of good data on student engagement and teacher attitudes about the instruction. Increased motivation for word study was one of the goals of the instruction. While success in this aspect of instruction has been reported anecdotally, future research should systematically investigate the question of student motivation and teacher attitudes.

In light of the current positive results, it would be valuable to investigate the effect of similar morphological instruction with populations identified for reading and/or learning disabilities. One question is whether students identified for phonological processing deficits are able to capitalize on this instruction as a compensatory strategy for literacy learning. It might be that gaining awareness of the concrete representations of morphemes with the aid of the word matrices and word sums would give particular benefits to students who typically struggle to make sense of the writing system.

There is a clear implication from these results that research and practice should investigate the effects of providing children with a more explicit and complete understanding of the English spelling system. Since morphology is a fundamental feature of how words work to represent meaning, the potential for developing a child's interest in and understanding of how words work—their word consciousness—is hindered by instruction that fails to address morphological structure. Findings from this study suggest that morphological instruction should be organized to facilitate students' ability to identify the bases of words. For example, instead of asking children to attend to *-tion* as a suffix in words such as *prevention*, *question*, or *action* (as we have seen classroom materials do), it may be more helpful to direct them to the suffix *-ion*, which makes it easier to see the base in those words. The current study has shown that instruction about the details of written morphology aids the ability of students in Grades 4 and 5 to recognize meaning cues in complex words and build vocabulary.

Four decades ago, the linguist Richard Venezky wrote, "…the simple fact is that the present orthography system is not merely a letter-to-sound system riddled with imperfections, but, instead, a more complex and more regular relationship wherein phoneme and morpheme share leading roles" (Venezky, 1967, p. 77). Results from this study support the common sense idea that English literacy instruction should accurately represent the basic principles of how the English orthography system works to represent the meaning of words.

Appendix

See Table 4.

Table 4 Words for *Base Identification* and *Morphological Vocabulary* by word category

Word taught	Base taught	Affixes taught
1. Busily	1. Reproduce	1. Refereeing
2. Staring	2. Condensed	2. Insensitive
3. Architecture	3. Socially	3. Decreasing
4. Victoriously	4. Ruder	4. Precautions
5. Adaptation	5. Insignificance	5. Prearranged
6. Educated	6. Incorruptible	6. Reelected
7. Vacuum	7. Stared	7. Acknowledgement
8. Conscious	8. Restructured	8. Responsibilities
9. Condensation	9. Vacuous	9. Accompanying
10. Starring	10. Happenstance	10. Scarred

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