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Cognition and Instruction

ISSN: 0737-0008 (Print) 1532-690X (Online) Journal homepage: http://www.tandfonline.com/loi/hcgi20

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To cite this article: Amy C. Crosson & Margaret G. McKeown (2016) Middle School Learners' Use of Latin Roots to Infer the Meaning of Unfamiliar Words, Cognition and Instruction, 34:2, 148-171, DOI: 10.1080/07370008.2016.1145121

To link to this article: http://dx.doi.org/10.1080/07370008.2016.1145121

COGNITION AND INSTRUCTION
2016, VOL. 34, NO. 2, 148–171
http://dx.doi.org/10.1080/07370008.2016.1145121

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Middle School Learners' Use of Latin Roots to Infer the Meaning of Unfamiliar Words

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ABSTRACT

This study investigated how middle school students leverage information about bound Latin roots (e.g., *voc* in *advocate* and *vociferous*) to infer meanings of unfamiliar words, and how instruction may facilitate morphological analysis using roots. A dynamic assessment of morphological analysis was administered to 29 sixth graders ($n = 17$ intervention students) and 30 seventh graders ($n = 18$ intervention students). Qualitative analyses of analytic strategies revealed patterns of morphological problem solving that included *direct* (i.e., direct application of roots to analyze unfamiliar words) and *indirect routes* (i.e., use of known words that carry the roots to analyze unfamiliar words). Intervention students applied a direct route at higher rates than control students. Correlational analyses revealed a small but significant treatment effect on establishing meaning memory representations for roots and a significant, positive treatment effect for use of roots to infer unfamiliar word meanings. Overall results show promise for use of bound Latin roots for morphological problem solving.

As students transition from elementary to middle school, they are expected to learn from content-area texts that are not only conceptually dense but also are more linguistically complex than those they encountered during the elementary years (cf. Carnegie Council on Adolescent Literacy, 2010; Nagy & Townsend, 2012; Snow & Uccelli, 2009). In particular, the vocabulary demands of academic texts present a significant hurdle to successful reading comprehension and content learning for many students in middle and high school (cf. Carnegie Council on Adolescent Literacy, 2010; Corson, 1997; Townsend, Fillipini, Collins, & Biancarosa, 2012). Nagy and Anderson (1984) estimated that there are over 225,000 words in school texts (grades 3–9). How can students possibly acquire knowledge of so many words?

One explanation is that students acquire metalinguistic knowledge about words' morphological constituents that enables generative word learning processes. Nagy and Anderson (1984) found that of the daunting 225,000 words, about 170,000 of these are morphologically complex words. They asserted that well over three quarters of derived words can be easily inferred (i.e., *hunter* can be easily inferred by children who know the meaning of *hunt*) or with "reasonable help" from context (*gunner* can be inferred from *gun* and a context about some sort of military operation). Nonetheless, this leaves over 40,000 morphologically complex words whose meanings are not easily inferred, presenting a formidable challenge.

Yet there is an aspect of morphology that has been largely overlooked in the research literature that may equip students to infer meaning of a large portion of words previously not considered candidates for morphological problem solving. Theory would suggest that *bound Latin roots* could help students overcome the large academic word demands they face. In the present study, we investigate a heretofore

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little investigated aspect of morphological problem solving—the use of morphological information about bound Latin roots to infer meanings of unfamiliar words.

Bound Latin roots and morphological problem solving

Morphology has garnered a great deal of attention in recent years, as there is now extensive evidence that morphological knowledge plays an important role in literacy acquisition in English (cf. Carlisle, 2010; Nagy, Carlisle, & Goodwin, 2014). In English, *morphemes* are the smallest units of a word that carry meaning. Morphemes can be inflectional (e.g., suffixes that change tense or number, such as the plural marker –s added to *schools*), derivational (i.e., prefixes and suffixes that alter form and/or meaning, such as un- and –ed added to *unschooled*), or they can be lexical (i.e., free standing units such as *school*, or bound roots such as *liter* in *literate*).

Morphological awareness is the metalinguistic insight that words are made up of these meaningful units. We adopt Carlisle's definition of morphological awareness as the "ability to reflect on, analyze, and manipulate the morphemic elements in words" (Carlisle, 2010, p. 466). Morphological awareness is linked to several components of literacy for native English speakers, such as positive associations with decoding (e.g., Singson, Mahony, & Mann, 2000), word identification (e.g., McCutchen, Logan, & Biangardi-Orpe, 2009), and spelling ability (e.g., Kemp, 2006; Leong, 2000; McCutchen & Stull, 2015). There is also converging evidence that morphological awareness holds strong, positive associations with vocabulary knowledge (Anglin, 1993; Carlisle, 2000; Nagy, Berninger, & Abbott, 2006) and predicts reading comprehension (Carlisle, 2000), even predicting unique variance in comprehension after controlling for vocabulary knowledge (Nagy, Berninger, & Abbott, 2006; Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003; Wagner, Muse, & Tannebaum, 2007) or prior comprehension performance (Foorman, Petscher, & Bishop, 2012).

Bound Latin roots as one type of morphological knowledge

Studies of morphological knowledge and instruction have focused on stem-words and derivational prefixes and suffixes (e.g., Baumann, Edwards, Boland, Olejnik, & Kame'enui, 2003; Baumann, Edwards, Font, Tereshinski, Kame'enui, & Olejnik, 2002; Kirk & Gillon, 2009), often referring to the manipulated units as "roots." This illustrates a challenge in understanding the role of morphology—use of consistent terminology. We have chosen to use the following terms:

- We use "stem-word" to refer to the morphologically simplest derivation of a word that is freestanding. For example, *vocal* is the stem of *vocalize* or *vocalization*. Others have used the terms such as "base word" or "root word" to refer to this concept.
- We use "bound root" to refer to roots, most often from Latin, that are the semantic basis of English words but are not free-standing words in English. For example, *voc* meaning "speak," is the Latin bound root in *advocate* and *vocalize*.
- When referring to relationships between words via bound roots, we use "root-related word" to indicate freestanding words that share a bound root. For example, the following are all root-related words: *vocal, vocalize, vocalization, vocabulary, advocate* (as they all contain the bound root, *voc*).

Why is it important to distinguish bound roots from stem-words? Words that students analyze in elementary grades are often of Germanic origin and are made up of stem-words to which prefixes and suffixes can be cleanly and efficiently added and subtracted (Bar-ilan & Berman, 2007). However, academic words rarely contain such transparent, freestanding stem-words (Tyler & Nagy, 1989); in fact most words on the Academic Word List (Coxhead, 2000) are Latinate (Lubliner & Hiebert, 2011), with their main semantic components being bound roots. As such, morphological analysis of words likely to appear in academic texts may call on knowledge of Latin bound roots. Morphological analysis of bound roots could be highly generative given that roots often carry substantial information about a word's meaning. Consider that the word *illuminate* contains the root *lumin*, from Latin for *light*; but if a learner does not know the meaning of *lumin*, knowledge about

the word's derivational affixes *il* and *ate* are not likely to be helpful. Knowledge of the bound root meaning, on the other hand, might support accessing the meaning of words such as *luminous* and *luminary*.

Theoretical framework: The role of bound roots in word learning

Our study draws primarily on Schreuder and Baayen's (1995) model of morphological processing, which accounts for how morphemes come to be represented in the lexicon. The model proposes that over the course of multiple encounters, learners develop connections between orthographic strings and their corresponding meanings. When the learner detects a redundant relationship between form and meaning, a "concept node" is created; each time the unit is encountered, the strength of the representation becomes stronger and accumulates additional semantic and syntactic information. For example, when the morpheme *nov* meaning "new" is encountered in multiple words such as *novelty* and *renovate*, learners may create a concept node for *nov* and its meaning that would become increasingly specified and robust with each encounter. According to this model, when an unfamiliar morphologically complex word is encountered, the learner activates relevant concept nodes (i.e., the meanings indexed by the morphological constituents) to hypothesize how the morphemes might be combined to infer word meaning, checking this hypothesis against other semantic and syntactic information from the context.

Although in this model, both whole, freestanding words and morphemes have the potential to be represented by concept nodes, the framework is not adequate to explain a learner's use of bound morphemes. For Schreuder and Baayen (1995), frequency and transparency are key to a learner's ability to activate and strengthen nodes, yet bound roots are not always redundant and transparent enough to activate their own nodes. Indeed, several dimensions may affect the accessibility of the morphological constituent. First, the bound root's *semantic transparency* will likely affect its accessibility such that opaque bound roots will probably not be accessible.[1] Second, the bound root's *phonological transparency* may affect its accessibility; bound roots with more than one phonological form may take longer to see than bound roots with a single form (e.g., there is a vowel shift in *novice* versus *renovate*, which may affect the accessibility and stability of its representation).[2] Finally, the bound root's *orthographic stability and uniqueness* may affect the morpheme's accessibility, as roots that shift orthographically (e.g., *vid* and *vis* both meaning "see") are likely to be less accessible, and roots represented by common orthographic strings (e.g., *no* meaning "know" as in "notify") will be more difficult to detect.[3]

Thus a framework for the role of bound morphemes needs to be augmented by further constructs. One such construct is metalinguistic awareness such as Nagy and Scott (2000) describe as necessary to understanding morphological relationships that are obscured by changes in spelling and pronunciation. Thus we hypothesize that learners need both *established memory representations* (i.e., concept nodes) for bound roots and their meanings and the *metalinguistic insight* about how to use this information for problem solving.

Moreover, given the characteristics of bound roots that learners need to bring to bear in order to access the relevant root (semantic transparency, phonological transparency, and orthographic stability and uniqueness), our theory of morphological problem solving using bound roots also emphasizes a third construct, *flexibility in applying root meanings* to infer new word meanings. Such flexibility is a specific case of a well-documented aspect of cognitive processing, cognitive flexibility, which involves considering multiple aspects of thought at once (Deak, 2003; Scott, 1962). For example, success at using bound Latin roots requires being able to switch one's focus from a single, precise orthographic form of the root to considering other possible orthographic representations (*vid* and *vis*). It also requires flexibility for learners to apply their understanding of the root meaning as it makes sense in a particular context, as it is rarely sufficient to bluntly "plug in" a root's meaning. Similarly, vocabulary researchers identify flexibility as needed for learners to adjust their focus between word meanings and context, and to consider possible alternate meanings in order to understand the fit of a word in a novel sentence (Deane, 2014; Pearson, Hiebert, & Kamil, 2012).

The role of bound Latin roots in word learning and processing: Indirect or direct route?

Despite the theoretical basis for asserting that knowledge of bound roots should support morphological analysis to infer learning new words, empirical evidence that bound roots are helpful to students is thin. Some evidence suggests that students leverage their knowledge of root-related words for morphological problem solving. In this case, the bound root is not invoked explicitly, but is the common morphological constituent used for inferring meaning of the unfamiliar word. For example, students recognize the relationship between an unfamiliar word (e.g., *astronomy*) and a familiar root-related word (e.g., *astronaut*), and use the meaning of the familiar word to shed light on the meaning of the unfamiliar word. While the bound root *astro* (star) is never called on explicitly, it is the shared morphological constituent that gave insight into the unfamiliar word's meaning. We call this an *indirect route* for morphological problem solving with bound roots.

Alternatively, students might follow a *direct route* for morphological problem solving, such that they explicitly apply the meanings of bound Latin roots to analyze unfamiliar words that contain the roots. For example, when encountering the unfamiliar word *astronomy*, students might explicitly call on the meaning of the bound root for information about the word meaning (e.g., something to do with stars).

Morphological processing strategies similar to the indirect and direct routes have been observed in previous research, but more often for derivational affixes than for bound roots. For example, in his seminal study of morphological problem solving with students in the elementary grades, Anglin (1993) found some students followed a strategy akin to the indirect route for morphological problem solving when they were presented with a morphologically complex, unfamiliar word. He called this strategy "analogy." However, Anglin's participants employed this strategy only rarely, and they tended to tap derivational morphology rather than bound roots (e.g., use of *piglet* to problem solve *treelet*), such that evidence of an indirect route using bound roots was sparse and evidence of the direct route using bound roots was nearly absent.

In a study with adolescent learners in the middle school grades, Pacheco and Goodwin (2013) found some evidence that these older participants (many of whom were English learners) used bound roots in morphological problem solving, including strategies that seem to map (partially) onto both the direct and indirect routes. Evidence of a direct route relates to the researchers' observation that students used information about multiple morphological constituents (called "parts to whole"). In fact this was the most common strategy applied by middle school participants. However, it is important to note that the morphological constituents included use of larger morphological units beyond bound roots for morphological problem solving (e.g., analysis of *archeo+astronomer* in *archeoastronomer* as an example of parts-to-whole). As a result we are not certain how often and how effectively students were able to use bound roots specifically in their morphological problem-solving process.

The researchers also found evidence related to an indirect route. Following Anglin, Pacheco and Goodwin (2013) used "analogy" to describe use of word with a similar morphological form to problem-solve an unfamiliar word (e.g., use *spectator* to problem-solve the meaning of *introspective*). While this strategy was rarely employed by students (used in only 4% of problem-solving episodes), the researchers argue that it was highly effective when used. As such, Goodwin and colleagues (Goodwin, Gilbert, Cho & Kearns, 2014; Pacheco & Goodwin, 2013) have argued that knowledge of root-related words may be a key mechanism by which morphological constituents' orthographic, phonological, and semantic representations are activated in solving new word meanings. However, Pacheco and Goodwin included derivational affixes in the "analogy" classification (e.g., use of *pediatrician* to problem solve the meaning of *clinician* as any example of "analogy"). Thus, the role of bound roots specifically in morphological problem solving, whether students more effectively and efficiently pursue one route or the other, and how instruction might affect processing of bound roots are issues that remain unresolved.

Two additional studies also suggest that students may use bound roots for inferring the meanings of unfamiliar words, but similar to the study above, they do not focus squarely on bound roots. First, in a cross-sectional study with fifth and eighth graders to examine the mechanism by which morphological awareness links to reading comprehension, McCutchen and Logan (2011) investigated students'

ability to use morphological analysis to figure out the meanings of low-frequency unfamiliar words during reading. The task required students to read a word and choose the corresponding definition from three options. The target words designed to be morphologically accessible contained morphological constituents that gave information about the target word meanings. Their findings suggest that students do use morphological analysis to infer word meaning, and while their assessment was mostly focused on derivational morphology, it did include some items that called on knowledge of bound roots. For example, one item asked students to make a semantic connection between *talkative* and *verbose*, which derives from the bound Latin root *verb* (from *verbum*), meaning "word." McCutchen and Logan's findings suggest that morphological analysis using bound roots may be one strategy that children use to infer the meanings of unfamiliar words during reading.

Second, an intervention study by Bowers and Kirby (2010) investigated whether fourth and fifth grade students can learn to use morphological analysis to find information about word meanings. The instruction addressed not only derivational affixes but also both stem-words and bound roots—both of which were called "bases." The authors investigated whether such instruction leads to gains in vocabulary learning, and whether this knowledge transfers to inferring meaning of low-frequency words that contain taught "bases" and derivational affixes. Controlling for initial vocabulary knowledge, Bowers and Kirby noted that intervention students were better able to define not only instructed words but also novel words that included "bases" taught during the intervention when compared to a control group. Bowers and Kirby concluded that teaching morphological analysis helps students learn vocabulary beyond the words taught. However, while the intervention included instruction in how to parse bound roots from morphologically complex words (e.g., *rupt* in disrupt), their outcome measure gave equal credit for extracting stem-words and bound roots. Thus the implications for bound roots, while promising, are unclear. In the present study, our approach privileges a direct route by investigating an instructional intervention in which students were taught to use bound routes to analyze word meanings. Further, our study examines what occurs when students attempt to use bound roots to infer word meanings and the process breaks down.

Effects of morphology instruction

While the relationship between morphological knowledge and literacy is strong, the effects of providing instruction in morphology, although positive, are somewhat less compelling. Interventions have demonstrated that morphology instruction has a moderate effect on vocabulary learning (Bowers, Kirby, & Deacon, 2010; Carlisle, 2010; Goodwin & Ahn, 2010, 2013). In a meta-analysis of studies with students in the elementary and middle school grades, Goodwin and Ahn (2013) found a statistically significant mean effect of morphology instruction for vocabulary (mean $d = 0.34$). For example, Baumann et al. (2003) taught students to use morphological knowledge to infer meanings of unknown words and found a large treatment effect for instruction about prefixes and stem-words (e.g., *prejudge, disloyal, rehire*), such that students were more successful at "unlocking the meanings of morphemically decipherable transfer vocabulary" (p. 464).

Context of the study

The present investigation was conducted in the context of a 2-year intervention with middle school learners, Robust Academic Vocabulary Encounters (RAVE; McKeown, Crosson, Artz, Sandora, & Beck, 2013). Five classrooms of students participated in the study from the beginning of sixth grade until the end of seventh grade. Each year, three classrooms received the intervention and two classrooms served as controls. The intervention focused on instruction for 99 words from the Academic Word List (AWL; Coxhead, 2000) in sixth grade and 96 AWL words in seventh grade. The intervention was based on consensus of principles of effective instruction derived over several decades including presentation of definitional and contextual information, encounters in multiple contexts, and active processing (Baumann, Kame'enui, & Ash, 2003; McKeown, Beck, Omanson, & Pople, 1985; NRP, 2000; Stahl & Fairbanks, 1986).

Table 1. Examples of Latin roots and related words from RAVE morphology lessons.

Root	Root meaning	RAVE word	Root-related words
Equ	Equal	Adequate	equation, equator
Loc	Place	Allocate	locate, dislocate, local
Form	Shape	Conform	uniform, transform, deform, reform
Sequ	Follow	Consequences	sequel, sequence
Min	Small/less	Diminish	minimize, minus, miniscule, mince, miniature, minor, minute
Tract	Drag	Extract	tractor, attract contract
Spect	See/look	Prospect	specimen, spectacles, inspect, prospector, respect
Fer	Carry	Transfer	ferry, prefer, odoriferous
Fy	To make	Unify	terrify, beautify

RAVE presented target words in multiple non-fiction contexts, and students were guided to integrate word meaning within different contexts. According to Bowers and colleagues (Bowers, Kirby, & Deacon, 2010), if morphological instruction is to transfer from the sublexical to word level and ultimately support comprehension at level of connected text, "this transfer is likely to be facilitated by instructional methods that integrate morphological instruction with other aspects of literacy instruction" (p. 149). Morphology instruction in RAVE equipped students with knowledge and problem-solving techniques to connect bound roots to the meaning of morphologically complex words in which they appear.

Research questions

Our research questions are as follows:

1. What are the patterns of morphological problem solving with bound roots that allowed students to infer meaning of unfamiliar words?
2. How did an academic vocabulary intervention with a morphological analysis component affect students' approaches to solving unfamiliar words using bound roots?
   a. Did the intervention support students to establish meaning representations in memory for bound roots, as indicated by their ability to recognize roots that had been taught and recall the meanings of these roots?
   b. Did the intervention support students to develop the metalinguistic insight that roots carry information about word meaning, as indicated by students' ability to use roots for morphological analysis to infer word meanings and comprehend them in context? Does this insight require established memory representations for bound roots?

Method

Intervention

The RAVE intervention comprised 12 units of seven daily lessons each in sixth grade, and 16 units of seven daily lessons each in seventh grade. Nine units in sixth grade and five units in seventh grade concluded with a lesson called "Becoming Aware of Language," whose focus was morphological analysis using bound Latin roots.

Between two and four roots were taught in the Becoming Aware of Language lesson (see examples in Table 1). The roots chosen for instruction were selected from the academic words that had been taught in that unit. A total of 34 roots was taught over the course of the intervention (18 in sixth grade and 16 in seventh grade); 30 of these were Latin roots and four were Greek. A total of 95 root-related words were taught (52 in sixth grade and 43 in seventh grade). A small number of prefixes were also taught in conjunction with the roots when they were key to word meaning. Teachers used the term "word parts"

to talk about morphological constituents in general, and they alternated between the terms "word part" and "root" when referring to the bound roots during instruction.

Instruction was designed to teach students to use an analytical, problem-solving stance toward morphological information. The goals of instruction were to teach that:

- a bound root is found within a word and it often provides information about the word's meaning;
- because these relationships have evolved over time, the relation is not always readily apparent;
- both the spelling and the pronunciation of roots can vary; and
- there are "false alarms," that is, just because you see a root does not mean it is necessarily there. For example, *val* carries the Latin root meaning "strong" in *value*, but it does not hold any etymological relationship to *valve, valley* or *medieval*.

Instruction proceeded as follows. The first step was to explain the origin of the bound root, provide its meaning, and invite students to analyze how the root's meaning connects to the meaning of the academic word they had studied. For example, to introduce the root, *spect*, the teacher wrote the RAVE word containing the root on the board (*prospect*) and underlined the bound root. She then explained that the bound root came from a Latin word meaning "to look at" and that "look" is the meaning of the root. Finally, she wrote the meaning below the underlined root on the board.

The second step was to engage students in analyzing how the root's meaning is connected to the meaning of other words that carry the same root (i.e., root-related words). In instruction, teachers called these "extension words." For example, after analyzing the relationship between the idea of "look" and the meaning of *prospect* (i.e., because a *prospect* is something that might happen, it's like *looking* forward into the future), students were asked to explain the relationship between the root and extension words such as *specimen* and *inspect*. Instruction also included teaching students that orthographic and phonological variation is a feature of bound roots by asking students to look at words side by side and note differences in how the bound roots' pronunciations and spellings varied. In this case, students were guided to see that the bound root can be written "spec" or "spect," and the "c" can be a hard or soft sound (e.g., *specimen, spectator*).

A transcript example from sixth grade illustrates how students were guided to directly relate the meaning of the bound root *min* (small) to the meanings of the root-related words, which were, in this case, familiar in meaning, *minus* and *minor*. Thus students were not being guided to infer word meaning, but to see the direct route from the meaning of *min* to the meanings of the two root-related words, a key feature of our RAVE morphology instruction.

Ms. H.: Okay what about minus. Take me through your thoughts for minus.

Tyler: Make it get smaller and smaller.

Ms. H.: Yeah and how do you do that?

Tyler: By subtracting.

Ms. H.: Yeah, so you're taking something away and making it smaller and smaller. … What about minor?

D'wayne: Like a small part of something. Yeah it's like a small part of something or less of something. If it's a minor hockey league it's … it's less. It's maybe not as competitive or maybe it's less skillful than the people who play the major leagues. If you're minor, like you're minors when you're less than 18 years old.

It is important to note that no further instruction about each of the bound roots was provided in subsequent RAVE lessons. While we cannot be certain, we believe that the type of morphological analysis with bound roots did not spill over into other content-areas or beyond the specific instructions. Teachers noted on several occasions that while they considered this content worthwhile and challenging, it was new to them as they had never studied Latin and had been largely unaware of the words' root meanings.

Control condition

In sixth grade, the intervention and control groups had the same basic language arts instruction from a basal reader, except that the daily vocabulary lessons from the basal reader were replaced by RAVE instruction for the intervention group. The basal lessons included minimal attention to morphology

in the form of applying common prefixes and suffixes to transparent, high frequency stem-words. In seventh grade, the RAVE and control groups had the same basic language arts instruction (they read the same novels and completed the same assignments), except that the intervention group received RAVE vocabulary lessons while the control group received lessons from an alternative vocabulary program with no overlapping words and no morphology component.

Participants

In the first year of the study, participants were 29 sixth graders selected from the five classes participating in the RAVE study, which took place in a public school within a working class community in the northeastern United States. Seventeen of the participants were drawn from the RAVE classrooms and 12 from the control classrooms. All students were native speakers of English. Students from each class were sampled to represent low-middle- to high-middle-performing students on the Gates-MacGinitie (MacGinitie, MacGinitie, Maria, & Dreyer, 2000) standardized reading pretest. An independent samples t-test confirmed no significant difference in prior reading achievement between the two groups ($t = .351$, $p = .363$).

In the second year, participants were 30 seventh-grade students, 18 who had participated in RAVE in both sixth and seventh grades and 12 who were in the control group for two years. There was no overlap of participants in sixth and seventh grades. In seventh grade, one teacher taught all five sections of English Language Arts offered at that grade level. Four of the sections were heterogeneously grouped; two of these were assigned to the intervention and two were assigned to the control group. From these four sections, participants ($n = 12$ RAVE and $n = 12$ control) were selected to represent low-middle- to high-middle-performing students on the Gates-MacGinitie (MacGinitie, MacGinitie, Maria, & Dreyer, 2000) standardized reading pretest. In addition to these four sections, one section was designated as an honors class. This section was assigned to the intervention ($n = 6$ Honors RAVE), hereafter called Honors RAVE. A one-way ANOVA revealed a significant difference on the Gates pretest between groups, $F(2, 27) = 11.95$, $p < .000$. Post-hoc pairwise comparisons confirmed that, as expected, Honors RAVE had significantly higher Gates pretest scores than students in the control and RAVE groups, *mean diff* $= 26.76$, $p < .000$ and *mean diff* $= 24.167$, $p < .000$, respectively. However, there was no significant difference between students in the control and RAVE conditions (*mean diff* $= 2.583$, $p = .586$). Thus all analyses were performed on the three groups: Honors RAVE, RAVE, and control.

While we are aware of evidence that high and low skill readers demonstrate different patterns in morphological problem-solving skill (Carlisle, 2003; Nagy and Hiebert, 2011), our sample was too small to make inferences about readers of different ability levels, thus we did not seek to test hypotheses about reading skill and morphological analysis, but rather included a sufficient range of students (excluding both struggling and highly advanced readers) so that we could be confident that our findings would likely generalize to a range of readers rather than a group at a particular skill level.

Dynamic assessment

Students' ability to engage in morphological analysis was measured using a researcher-designed, dynamic assessment. Dynamic assessment was selected because it provides rich information about students' thinking processes, especially for skills and knowledge that are still forming (Burton & Watkins, 2007; Poehner & Lantolf, 2010). As such, it reveals not only *whether* a student can successfully engage in morphological analysis of unfamiliar words, but *how*, as well as *where and how the process breaks down*. Thus this task assessed the process of applying morphological information rather than just the knowledge needed to do so. Similar measures have been used to investigate morphological problem solving of unfamiliar words by Anglin (1993) as well as by Pacheco and Goodwin (2013).

Dynamic assessment allowed us to see: (1) when students decompose words, do they recognize the bound Latin root as one of the units; (2) whether students link meaning information to this unit; and (3) whether students can integrate orthographic/phonological information and semantic information associated with the bound root to unlock the meaning of an unfamiliar word. For control students who

Table 2. Dynamic assessment items administered in sixth and seventh grades.

Root	Sentence presented
Sixth grade	
Crit	Laura was surprised by teacher's critique.
Min	Most of their conversations were about the minutiae of daily life.
Form	The middle school years are formative.
Mit	The animal emitted a strange sound.
Sent	Janet shares Maria's sentiments about surprise parties.
Equ	Some people equate ice cream frozen yogurt.
Uni	The children counted from one to ten in unison.
Seventh Grade	
Voc	Out on the street there was a vociferous crowd.
Sed/sid	The party was surprisingly sedate.
Vert/vers	The engineers tried to divert the river.
Mon	The doctor admonished the boy about his diet.
Val	The woman received publicity for her valor.
Var	The writer tried to come up with a variant ending.
Circum	The man always tried to circumvent the rules.
Clude	The tunnel to the playground was occluded.
Vid/vis	The house sold quickly because of its amazing vista.

Note. Target words are underlined.

had not been taught the bound roots, the question was whether—when given the information about roots needed for morphological analysis—they were they able to use this information as effectively as intervention students, or whether the RAVE students demonstrated greater potential to use information about bound roots for morphological analysis following their experience in the intervention.

In this task, the assessor asked students a series of questions to prompt morphological analysis of an unfamiliar word presented in a sentence-level context. The task comprised seven items in sixth grade and nine items in seventh grade. For each item, students were presented with a sentence that included a target word that contained one of the roots taught in the RAVE intervention. The target word itself, however, had never been used for instruction. Sentences were designed as neutral contexts for the words, so as not to provide hints about the word's meaning. For example, the bound root *min*, meaning "small" or "less" was taught with the RAVE word, *diminish*. The dynamic assessment for *min* contained the target word, *minutiae*: "Most of their conversations were about the minutiae of daily life." A complete list of items is presented in Table 2. A sample script is found in Appendix A.

Word selection

Target words were expected to be unfamiliar to sixth and seventh graders per their classification as 8th grade or higher on the Living Word Vocabulary inventory (Dale & O'Rourke, 1979). Confirming Living Word Vocabulary classifications, all target words had Standard Frequency Index (SFI) scores (i.e., log transformation of U-score) of less than 45 per the Zeno corpus (Zeno, Ivens, Millard & Duvvuri, 1995). Regarding morphological family size, the frequency of bound roots was determined using Becker and colleagues' (Becker, Dixon, & Anderson-Inman, 1980) corpus of morphographic units in the 26,000 highest frequency words in English. The bound roots tested were estimated to be in the top fifth of most frequent morphographs in English.[4] This is important in light of the fact that frequency of encounters with any morphological constituent impacts whether and how quickly that constituent will be recognized in other words (Nagy, Anderson, Schommer, Scott, & Stallman, 1989; Nagy & Hiebert, 2011). Word and root-level statistics are presented in Table 3.

Task instructions and procedure

All tasks were administered individually by a member of the research team in a quiet room in the school, and all sessions were audiorecorded. The task was introduced to the students by telling them, "we are interested in understanding more about what middle school students know about how language works, so we're going to talk with you about that today. We're going to look at some sentences and I'll ask you some questions." During the task, the assessors were directed to use the term "word

Table 3. Word and root-level statistics for morphological analysis items in dynamic assessment task.

Grade	Bound root	Target word	LWV classification	Zeno SFI	Bound root frequency
Grade 6					
	Crit	*Critique*	13	35.3	13
	Min	*Minutiae*	16	20.8	17
	Form	*Formative*	10	38.1	64
	Mit	*Emitted*	13	25.3	30
	Sent	*Sentiments*	8	42.8	40
	Equ	*Equate*	12	34.9	32
	Uni	*Unison*	8	42.5	34
Grade 7					
	Voc	*Vociferous*	16	28.8	23
	Sed/sid	*Sedate*	13	32.5	9
	Vert	*Divert*	16	32.6	29
	Mon	*Admonished*	13	36.4	26
	Val	*Valor*	10	37.2	15
	Var	*Variant*	12	36.3	17
	Circ	*Circumvent*	13	35	35
	Clude	*Occluded*	16	24.2	11
	Vis	*Vista*	12	38.2	61

Note. LWV = Living Word Vocabulary (Dale & O'Rourke, 1981); Zeno SFI = Standard Frequency Index scores in Zeno corpus (Zeno et al., 1995); Bound root frequency = frequency of root in the 26,000 highest frequency words in English per Becker and colleagues' corpus (Becker, Dixon, & Anderson-Inman, 1980).

parts," to avoid any confusion that might be caused by the inconsistent definitions in use in instructional for the terms root, root word, base, and stem, among others. Assessors were also permitted to use the term "root" with RAVE students since they had learned that term in instruction. Directions were as follows:

Step 1. The assessor presented a sentence in Times New Roman 20 point font on a strip of paper with target word underlined and read the sentence aloud. The assessor then asked the student to explain the meaning of the word in that context. For example, for the item, "Out in the street there was a vociferous crowd" the assessor asked, "What is this saying about the crowd?" and "What makes you say that?" Assessors were directed to move on to the next item if the student identified the root, *voc*, and explained the connection between the meaning and the sentence. However, students never made spontaneous, explicit connections to the root, thus subsequent questions of the dynamic assessment were asked in every case.

Step 2. The assessor directed the student to analyze the target word. In the example of the item for the bound root, *voc*, the assessor pointed to the underlined target word and said, "Look at the word vociferous. Do you see a word part that you recognize?" If the student identified any word part other than the bound root, the assessor acknowledged the student's observation ("yes, that is a prefix") and then repeated the question asking, "Do you see any other word part that you recognize?" If the student identified the bound root, the assessor circled it, or if the student was unable to identify the word part the assessor circled *voc* on the sentence strip.

Step 3. The assessor asked, "What does that word part mean?" If the student knew the meaning of the bound root (in this case, "speak" or "call"), the assessor confirmed and moved to the next step. If the student didn't know, the assessor showed another strip of paper with two words on it: the target word (vociferous) and the RAVE word containing the bound root (advocate). The assessor underlines the bound root in both words (voc) and told the student the definition of the word (i.e., *when someone advocates for a person or an idea it means that they speak up in favor of them*), and asks, "Does that help you remember what *voc* means?" If the student did not identify the meaning of the root, the assessor stated, "*voc* comes from a Latin root that means 'speak' or 'call.'"

Step 4. The assessor repeated the initial question: "So, does that give you any other ideas about the crowd?" If the meaning was clear, the assessor did not ask for additional interpretation or more exact meaning regardless of the accuracy or plausibility of their response (e.g., "a noisy crowd" or "lots of people speaking in a crowd"). However, if the meaning was not clear, the assessor was permitted to

repeat the question or ask a follow up (e.g., Any other ideas?). The average number of times each student was asked this question or a follow-up in seventh grade was 9.37, showing that on average students received less than one additional prompt during the assessment. All students were asked as a follow up, "What makes you say that?" At this point, if the student did not point to the root's meaning as the clue to the target word meaning, the assessor asked no more than two questions to determine whether the student was making a connection to the root, for example, "Can you point exactly to the word part you recognize?" and "So what word part are you seeing to say that it connected to voice?"

The administration procedure was exactly the same for RAVE and control students in seventh grade. Sessions were approximately 14 minutes per student. In sixth grade they were the same except that Step 3 differed, as control students were not presented with the RAVE word containing the bound root and provided with its meaning. Instead the assessor simply asked, "What does that word part mean?" and provided the meaning if the student did not know it.

Coding scheme

All sessions were transcribed and subsequently coded along three dimensions: *recognition, meaning*, and *comprehension*.

Recognition

Recognition indicated whether the student was able to identify the bound root in the target word: 0 = no, 1 = yes.

Meaning

Meaning indicated the degree to which students knew the meaning of the root: 0 = no or incorrect; 1 = provided meaning of the root, but only after prompting with RAVE word (e.g., provided meaning of *min* after being presented with *diminish*); 2 = provided meaning with no prompting.

Comprehension

Comprehension indicated how successfully students developed accurate meaning of the sentence by inferring the meaning of the target word based on the bound root: 0 = no attempt or student does not use root meaning; 1 = student applies root meaning to infer target word meaning and interpret the sentence, but does so inaccurately; 2 = student applies root meaning to accurately infer target word meaning and interpret the sentence.

In sixth grade there were three cases in which students knew the meaning of the target word at the outset of the task so it was impossible to determine whether they had applied the meaning of the bound root. These three cases (one control and two RAVE) were excluded from the analysis for the comprehension dimension only. In seventh grade, target words were familiar to students at the outset of the task in seven cases (three control, two RAVE and two Honors RAVE). These cases were excluded from the analyses for the comprehension dimension.

Reliability

Transcripts were blinded and coded by one member of the research team. Another researcher independently coded 20% of the transcripts, yielding 98% exact agreement on the recognition dimension, 92% for meaning and 81% for comprehension. Discrepancies were discussed and the final agreement rating was used in all analyses. Raters used a list of keywords that students must have used in stating the meaning of a root (e.g., for *circum* they had to use the word "around"; for *sed* they could use either "sit" or "settle").

Table 4. Distribution of morphological problem-solving strategies as the percentage of episodes in grade 7.

	Control	RAVE	Honors RAVE
Direct route	55.77	71.7	65.38
Indirect route	16.35	7.55	13.46
False connection	6.73	1.89	3.85
Conflation	2.88	15.09	15.39
No morphological problem solving	18.30	3.77	1.92

Note. $n = 262$ episodes.

Results

RQ1. Patterns of morphological problem solving with bound roots that allowed students to infer meaning of unfamiliar words

All transcripts from seventh grade dynamic assessment tasks comprising a total of 262 episodes (52 episodes from Honors RAVE, 106 from RAVE, and 104 from control) were analyzed for patterns of morphological problem solving. Two episodes were eliminated from Honors RAVE and RAVE in which the target words were already known (two students knew *sedate* and two knew *divert*); four episodes were eliminated from the control group (one student knew *sedate*, another knew *admonish*, and a third knew *occlude* and *vista*). Only seventh grade transcripts were analyzed because, as noted previously, the dynamic assessment task was administered identically to intervention and control students in seventh grade (whereas in sixth grade there was a discrepancy).

Episodes were classified into the following taxonomy of morphological problem-solving strategies observed in students' approaches to inferring meaning of unfamiliar words:

- Direct route: Student applied bound root to infer meaning of target word.
- Indirect route: Student applied a bona fide root-related word to infer meaning of target word.
- False connection: Student applied a word that appeared to be a root-related word, but it did not share the bound Latin root.
- Conflation: Student conflated the meaning of the RAVE word with the meaning of the bound root.
- No morphological problem solving: There was no evidence that the student engaged in morphological problem solving of any kind.

The distribution of strategies employed by students for morphological problem solving is presented in Table 4 as the percentage of episodes for which that strategy was observed. These patterns were derived based on where a student ended up at the conclusion of interactions for an item after having been provided support, as needed, to apply morphological information. As can be seen from Table 4, a direct route was overwhelmingly the most common approach taken by all groups. For the control group, the next most common pattern was lack of application of any morphological information, while only a small proportion of RAVE students failed to apply morphology. For the RAVE groups, the second most common approach was conflation of the RAVE word with the bound root. Table 4 also shows that all groups made use of an indirect strategy.

Below we illustrate each morphological problem-solving strategy by presenting excerpts from dynamic assessment transcripts for the item about the Latin root *voc* (meaning "speak"), which began with the sentence, "Out in the street there was a *vociferous* crowd." These excerpts provide insight into the affordances and constraints of morphological analysis, and the influence of the intervention on students' morphological problem-solving strategies.

Direct route

The intervention guided students to take a direct route in using bound roots for morphological problem solving. The dynamic assessment protocol implicitly modeled a direct route in morphological problem solving by asking about the meaning of the root and providing that meaning to students as needed. Although this strategy was the most common for all students, both RAVE and Honors RAVE students employed this strategy more frequently than students in the control group (Table 4). Students often

employed this strategy after initially being unable to provide an accurate interpretation when asked about the sentence, and unable to recognize the root or its meaning.

The two students whose excerpts appear below invoked a prototypical feature of crowds—their size—when first asked about the meaning of the context, which was a typical initial response to this item. Yet the students both earned a score of 2 for the comprehension dimension after information on root meaning was provided. Their excerpts illustrate how students were able to use information about bound roots for morphological problem solving, even when they could not provide the meaning of the bound root without assistance.

Nate, a RAVE student, selected *voc* when prompted to identify a root, but did not recall its meaning until reminded of the RAVE word *advocate* and its meaning. He then applied the idea of "loud or talkative" to the crowd.

A: Looking at vociferous, do you see any word parts that you recognize?

S: Um, voc.

A: Voc. Bingo, you got it. Do you remember what voc means?

S: Can't remember.

A: Alright. Let's take a look at a couple of words here; see if this rings a bell. So we have voc in vociferous and voc in advocate. So when someone advocates for a person or idea, it means they speak up in favor of it. Does that help you remember what voc means?

S: Very loud? Talkative?

A: You're really close. It's a Latin root that means speak or call. Does that give you any other ideas about the crowd?

S: Um like a talkative crowd. A loud, talkative crowd.

Kianna, a control student, first identified the target word's suffix (i.e., -ous), but after the assessor pointed her to the root and provided its meaning, she successfully used it to make sense of the context.

A: Okay, So we want to pay attention to this word here: vociferous. Do you see a word part in vociferous that you recognize?

S: -ous.

A: Good. That's one word part. Let's also look at this word part right here: voc. Do you know what that word part means?

S: No.

A: Okay, so if we look at these two words … here's vociferous again and this is the word, advocate. Have you ever heard that word?

S: No.

A: Okay, when somebody advocates for a person or idea, that means they speak up in favor for them. … So voc means to speak or call. Does that give you any other ideas about the crowd?

S: So it's a noisy crowd?

Notice that Kianna immediately moved from hearing the root meaning to directly incorporating that idea into what it would mean about a crowd—"a noisy crowd?" Kianna's interaction illustrates that even students who did not participate in the intervention were able to successfully apply the meaning of bound roots for morphological problem solving through the guidance of the dynamic assessment protocol, albeit with lower frequency.

In other cases, students directly applied the meaning of the bound root, and arrived at a plausible but not completely accurate interpretation of the context. Such responses received a score of 1 on the comprehension dimension. Below two such examples are presented. In both, the student initially provided an inaccurate interpretation of the context and did not recognize *voc* or its meaning. At this point in the task, the assessor has provided the meaning of *voc* and is giving students an opportunity to interpret the context using this information. The first example is from Marissa, a RAVE student.

A: Would you like to add anything else? Other ideas about the crowd?

S: Um that they like talk like they talked a lot like maybe they have a lot of ideas or stuff to say about where they were.

This next example is from Nicole, an Honors RAVE student.

A: Yes, so it's speak or call. It's a Latin root. So does that give you any other ideas about what was happening out in the street?

S: Um a little bit. It tells me that there's a lot of people speaking in the crowd.

In the two examples, the students used the root meaning, "speak," but interpreted the context to mean that the people on the street were speaking to each other, sharing ideas, thus missing the key element of "noisiness" that *vociferous* represents. Although their interpretations were not completely accurate, both students strategically applied the information about the Latin root and integrated it with the context in a plausible way, reflecting the morphological problem solving approach taught in the intervention.

Indirect route

Students in all groups sometimes applied an indirect route (i.e., Anglin's "analogy" approach), using a root-related word (other than a RAVE word) as their analytic tool to problem-solve the meaning of the unfamiliar word. This strategy was not explicitly taught in the intervention, but it has been observed as a morphological problem-solving strategy (Pacheco & Goodwin, 2013) even in the absence of instruction about bound roots (Anglin, 1993). In the examples below, the students immediately apply the strategy when they are presented with the stimulus sentence, and both are scored 2 for the comprehension dimension. The first excerpt is from control student, Tony:

A: So what do you think this is saying about the crowd?

S: Loud.

A: What makes you say that?

S: Um cause I see vocif, which reminds me of voice.

A: Vocif reminds you of voice? Okay, super.

Even though Tony's initial interpretation of the sentence was accurate, the assessor proceeded with the protocol, directing Tony's attention to *voc*, and eventually explaining the meaning of the root. She then gave Tony another opportunity to interpret the sentence, and Tony expanded his comments about the loudness of the crowd, saying "there's a lot of people talking and things like that."

An Honors RAVE student, Andrea, made a similar connection between the root and the target word, also apparently based on the morphological relationship between *voice* and *vociferous*:

A: So what do you think this is saying about the crowd?

S: The crowd was loud.

A: Loud? Okay, what makes you think that?

S: Because it has voice in it. And voice usually means loud or speaking. So there was a lot of talk in the crowd. Very loud.

Both Andrea and Tony arrived at a correct interpretation of the sentence, and both provided a rationale based on identification of a root-related word. It is interesting that students made these connections in spite of the orthographic shifts (of vowels) between *voc* and *voice*. Students in the intervention had been taught to be aware of orthographic variation in Latin roots, especially for vowels, but students in the control condition had not. Nonetheless, control students made these connections more frequently than intervention students.

False connections

There were also some instances of efforts to link to a root-related word that the student believed was morphologically related, but was not. This kind of faulty link was observed infrequently—just 10 times out of a possible 262 episodes in the study. Such links are illustrated in the excerpts below. The first is from control student, Nick:

A: In the word, vociferous, do you see a part that you recognize?

S: Ferious.

A: Here? Ferious. Okay, Let's look at this one: voc. Do you have any idea what that word part means?

S: No.

A: Okay. [Shows advocate and underlines voc.] When someone advocates for a person they speak up in favor of them. Does that you have figure out what voc means?

S: What it could mean …?

A: This word part comes from a Latin root that means speak or call. So, out on the street there was a vociferous crowd. Would that tell you anything, knowing that?

S: Mad crowd.

A: Mad crowd? How do you know they would be mad?

S: I saw furious.

Notice that Nick was unable to override his initial hypothesis, even after the root and its meaning were provided. This episode was scored 0 on the comprehension dimension.

Another example of a faulty link was included in RAVE student, Miranda's, responses. Note that she identifies both the target root and a faulty one: "*Voc*—that would kind of remind me of voice, and then that [ferous] reminds me of furious."

Finally, Honors RAVE student, Seth, hypothesized a morphological relationship between *vociferous* and *violent*: "Um, vociferous. It sounds like … it looks like a word like violent."

In many cases of faulty links, students—including Miranda and Seth above—were able to set aside these misleading connections and switch their thinking, after the root was identified during the task. These students then went on to use information about the root to reach a correct interpretation of the context. For these students, entertaining a range of morphological relationships between words—some of which were faulty—seemed to function as part of a brainstorming or problem-solving process. This suggests that an important principle of morphological analysis may be flexibility in testing out word relationships and considering and applying root meanings. A flexible approach to applying root meanings to infer new word meanings was a principle of morphological problem solving with bound roots that was consistently modeled and guided in the intervention.

Conflation

Another morphological problem solving strategy observed was conflation, which arises from failure to separate aspects of knowledge, such as word meaning, from a broader context, or root meaning from the whole word (McKeown, 1985; Werner, 1954). In the current cases, students had difficulty separating the meaning of RAVE words from the meaning of Latin roots, even after the assessor provided the meaning of the Latin root. Several examples of this occurred with the *voc* item when the assessor presented the RAVE word, *advocate*, as an example of a word that contains the *voc* root, and told students both that "when somebody advocates for a person or idea, that means they speak up in favor for them" and also that "*voc* means speak or call."

Most students whose responses followed this pattern ultimately had limited success in inferring the unfamiliar word's meaning, as illustrated in the follow three responses to the final question in the dynamic assessment interview protocol, "does this give you any other ideas about the crowd?" These episodes were scored 1 on the comprehension dimension.

- Control student, Savannah: "They're speaking out about how they feel?"
- RAVE student, Hailey: "They're like a protesting crowd."
- RAVE student, Elizabeth: "Like, out in the street like people were speaking about rights and stuff. Like they were like we want equal rights and stuff. And they're speaking for like which person they want to vote for or something."

In the following excerpt from Honors RAVE student, Emily, notice that when asked about the meaning of *voc*, she first assigned it the meaning of the entire word *advocate*. But when the assessor explained that *voc* means "speak or call," Emily was able to apply this information to infer the meaning of *vociferous* in context. Thus Emily evidences the flexibility to separate the conflated elements and infer a more relevant fit to the context that is focused on the root's meaning.

This episode was scored 2 on the comprehension dimension.

A: Well let's look at two words that share [the root *voc*]. So we have *voc* in vociferous and we also have it in *advocate*. When a person advocates for another person, they speak up in favor of them. Does that remind you of what *voc* means?

S: Yeah like you speak for it and you like help it.

A: Right so it comes from a Latin root that means to speak or to call. Voc. Does that give you any other ideas about the crowd out in the street?

Table 5. Descriptive results for the morphological analysis dynamic assessment in grade .

	n	Recognition (max = 9) *M (SD)*	Meaning (max = 18) *M (SD)*	Comprehension (max = 14) *M (SD)*
RAVE	17	6.53 (1.66)	4.29 (2.26)	10.38 (1.59)
Control	12	2.50 (1.57)	2.25 (1.91)	8.64 (1.96)

S: There was a lot of talking.
A: Right so what kind of crowd would it be then?
S: A noisy crowd.

This pattern occurred infrequently with control students and with greater frequency with both RAVE and Honors RAVE students, presumably because conflation is grounded in knowledge—in this case of the instructed words—but reflects a naïve stage of application of that knowledge—the inability to separate the meanings of the word and the root

RQ 2. Intervention Effects on Students' Approaches to Solving Unfamiliar Words Using Bound Roots?

A. Did the intervention support students to establish meaning representations for bound roots, as indicated by their ability to recognize roots that had been taught and recall the meanings of these roots? Means and standard deviations for the three dimensions are presented in Table 5 for sixth grade and Table 6 for seventh grade.

Recognition

For sixth grade, a one-way ANOVA on the *recognition* dimension revealed a significant difference between groups, [$F(1, 27) = 43.29$, $p < .000$] demonstrating a large treatment effect (partial $\eta^2 = .616$). Assumptions of heterogeneity of variance and normality were met.

For seventh grade, a one-way ANOVA on the *recognition* dimension showed a significant difference between groups, $F(2, 27) = 23.68$, $p < .000$, as was the case in Study One. The assumption of homogeneity of variance was met and the assumption of normality was met for all groups except for the control group. In order to determine the pattern of difference among groups on the recognition dimension, post-hoc pairwise comparisons using a Bonferroni adjustment were performed. Students from the control group had significantly lower scores than both the RAVE and Honors RAVE groups, *mean diff* $= -3.58$, $p <$ .000, Cohen's $d = 2.38$ and *mean dif* $= -3.50$, $p < .000$, Cohen's $d = 2.93$ respectively, revealing large treatment effects according to Cohen (1988). There was no significant difference between RAVE and Honors RAVE groups (*mean diff* $= .083$, $p = . 91$).

Meaning

For the *meaning* dimension in sixth grade, a one-way ANOVA showed that there was a significant effect of the intervention, as there was significant difference between groups $F(1, 27) = 5.97$, $p = .021$ revealing a small treatment effect (partial $\eta^2 = .181$). Assumptions of heterogeneity of variance and normality were met.

For seventh grade, a one-way ANOVA showed a significant difference between groups, $F(2, 27) =$ 12.42, $p < .000$. The assumption of homogeneity of variance was met. The assumption of normality was met for the RAVE group, but not for control and Honors RAVE. Post-hoc pairwise comparisons using a Bonferroni adjustment revealed that, as expected, students from the control section had significantly

Table 6. Descriptive results for the morphological analysis dynamic assessment in grade 7.

Condition	*n*	Recognition (max = 9) *M (SD)*	Meaning (max = 18) *M (SD)*	Comprehension (max = 18) *M (SD)*
Control	12	2.50 (1.57)	1.50 (1.88)	8.22 (3.35)
RAVE	12	6.08 (1.44)	4.75 (2.30)	11.55 (3.17)
Honors RAVE	6	6.00 (0.63)	6.33 (2.25)	14.25 (2.63)

Table 7. Nested taxonomy of hierarchical regression models predicting the influence of the recognition and meaning dimensions on the comprehension dimension in grade 7.

Model	Prior reading achievement β	Promptsβ	Conditionβ	Recognitionβ	Meaning β	Adj. R2	ΔR2
1	.673***					.428	.453***
2	.691***	.278				.485	.077
3	.554**		.337*			.509	.099*
4	.516**		.105	.207	.137	.573	.021*

Note. $n = 30$. Controlled for prior reading achievement, number of prompts, and condition. Prior reading achievement = Extended Scale Score on Gates-MacGinitie Reading Test (MacGinitie, MacGinitie, Maria, & Dreyer, 2000).
* $p < .05$, ** $p < .01$, *** $p < .001$.

lower scores on the meaning dimension than students in both the RAVE and Honors RAVE groups, *mean diff* = −3.25, $p < .001$, Cohen's $d = 1.55$ and *mean diff* = −4.83, p < .000, Cohen's $d = 2.33$, respectively, revealing large treatment effects. However, there was no significant difference between RAVE and Honors RAVE groups (*mean diff* = 1.583, $p = .15$).

Prior literacy performance as measured by Gates-MacGinitie reading score did not affect performance on the *recognition* and *meaning* dimensions in either sixth or seventh grade. In all cases, the assumption of homogeneity of regression was met but Gates-MacGinitie total reading score was not a significant covariate.

B. Did the intervention support students to develop the metalinguistic insight that roots carry meaning, as indicated by their ability to use roots for morphological analysis to infer word meanings and comprehend them in context? Does this insight require established memory representations for bound roots?

For the *comprehension* dimension, in sixth grade a one-way between-subjects ANOVA confirmed that intervention students had significantly higher scores than those in the control condition, $F(1, 24) = 6.222$, $p = .020$], demonstrating a small treatment effect (partial $\eta^2 = .206$). Assumptions of heterogeneity of variance and normality were met.

For seventh grade, we compared students' scores on the *comprehension* dimension with a one-way ANOVA. The assumption of normality and homogeneity of variance were met. As anticipated, there was a significant difference between groups, $F(2, 27) = 56.73$, $p < .011$. Post-hoc pairwise comparisons confirmed that students from the control section had significantly lower scores on the *comprehension* dimension than both the RAVE and Honors RAVE groups, *mean diff* = −3.32, $p = .03$, Cohen's $d = 1.02$ and *mean diff* = −6.03, $p = .005$, respectively, Cohen's $d = 2.00$, revealing large treatment effects. There was no significant difference between RAVE and Honors RAVE groups (*mean diff* = 2.71, $p = .16$).

For the *comprehension* dimension, the covariate, prior reading achievement as measured by Gates reading score, was a significant predictor. However, the assumption of homogeneity of regression was not met, so it was not included as a covariate in the final model for this dimension. We acknowledge that prior reading performance does seem to differentially influence students' ability to use morphological analysis to infer meanings of unfamiliar words in context, which corroborates previous findings (Carlisle, 2003; Nagy & Hiebert, 2011) and is addressed in subsequent regression analysis.

We anticipated that students who were more successful on the recognition and meaning dimensions would also be more successful at using morphological analysis to make sense of the context. To test this hypothesis, a series of hierarchical regression analyses was performed to explain variance on the comprehension dimension in seventh grade (Table 7). Since the number of prompts given to students during the dynamic assessment varied by student and item and may have affected students' morphological problem-solving performance, all seventh grade transcripts were analyzed for the number of prompts provided to students and the number of prompts provided was included as a control variable in the hierarchical regression model building. Prior reading achievement was entered as a control variable in Model 1, followed by the number of prompts provided during the dynamic assessment in Step 2, Model 2. The number of prompts did not explain significant unique variance in performance on the comprehension dimension and therefore was dropped from subsequent models. In Model 3, prior reading achievement was entered as Step 1, followed by condition of instruction in Step 2. In Model 4, the meaning and

recognition dimensions were entered in Step 3. In Model 4, prior reading achievement by itself explained 51.6% of the variance on the comprehension dimension. Condition of instruction, when entered in Step 2, explained nearly an additional 10% of the variance. It is interesting to note that condition was a significant predictor of performance on the comprehension dimension, explaining an additional 9.9% of unique variance, even after controlling for prior reading achievement. However, the recognition and meaning dimensions, when entered into Step 3, were not significant predictors. (Note that condition was no longer a significant predictor with the recognition and meaning dimensions in the model.) The final model predicts that whether or not students recognize roots in unfamiliar words and recall the meanings of those roots does not influence the degree to which students are able to uptake the morphological information and use it to support comprehension, when controlling for prior reading achievement and instructional condition.

Discussion

In this study, we investigated how adolescents make use of the information provided by bound Latin roots for morphological problem solving. Working with bound roots is more complex than working with the transparent base or stem-words typically selected for morphology instruction, yet roots hold potential value for supporting word-learning and comprehension, as they are ubiquitous in academic words and carry semantic information.

Our hypothesis about mechanisms underlying morphological analysis ability was grounded in Schreuder and Baayen's (1995) theoretical model of morphological processing and guided by Nagy and Scott's (2000) observations about the challenges of accessing opaque morphological components. Specifically, we hypothesized that the mechanism by which Latin roots support word learning processes entails both the establishment of concept nodes for bound roots and the metalinguistic insight that bound roots carry meaning and that learners would need both established memory representations for bound roots and their meanings and the metalinguistic insight about how to use this information for problem solving. Finally, we expected that flexibility in applying root meanings to infer new word meanings would be important, given the dimensions that affect access to information about bound roots (semantic transparency, phonological transparency, and orthographic stability and uniqueness). The theory of learning presented here opens the possibility for development of generative knowledge of word meanings that goes beyond the work in derivational morphology to work with bound roots.

Our results showed that, when prompted within a dynamic assessment, students were quite able to engage in morphological analysis. Students who had had some instruction about Latin roots were more likely to do so, and did so more successfully. Results from both sixth and seventh grade showed that students who had experienced the RAVE intervention were more likely to recognize the roots, to understand that the root meanings are connected to the meanings of the words in which they appear, and most importantly were more successful at using this information to comprehend contexts. Our results also showed that the minimal amount of instruction embedded in our dynamic assessment was enough for many control students to take advantage of the information afforded by Latin roots.

Our findings give insight about not only whether middle school students can engage in morphological analysis using bound Latin roots, but also where and how the process breaks down. One pattern observed was that of conflation, when students assumed complete overlap in meaning between the word and root; this nearly always led to implausible or inaccurate inferences about unfamiliar words carrying the root. A similar tendency has long been observed at the word level, when students learning a new word meaning conflate it with the meaning of the context in which it appears (Werner & Kaplan, 1950). However, now we see similar processing difficulties at the level of bound roots.

Our results provide a nuanced account of bound roots as a language resource and demonstrate that the role of bound roots in comprehending language is quite complex. We did not find a straightforward cause/effect path from recognizing a root to using it to infer word meaning. The theory of learning is not a straightforward strengthening mechanism. Rather, our results suggest that successful use of bound roots entails a metalinguistic insight that bound roots provide information about word meaning and cognitive flexibility in applying the information afforded by bound roots. As well, our results suggest

that such learning is susceptible to instructional intervention. Finally, while the present study did not attempt to unravel the impact of phonological, orthographic, and semantic transparency on morphological problem solving, we anticipate that morphological problem solving with bound roots will be affected by characteristics of the individual roots and the words in which they appear, as has been found in studies of derivational morphology (Carlisle, 2000; Carlisle & Stone, 2005).

The intervention, conducted over two academic years (sixth and seventh grades), guided students to take a "direct route" in using bound roots for morphological problem solving. Students were taught the meaning of bound roots and were guided to use this information to see connections to the meanings of other familiar root-related words (e.g., seeing how *min* from *diminish* relates to *minus* and *minor*). Students were then guided to infer meaning of unfamiliar root-related words, for example, by, seeing how *fer* from *transfer* helps shed light on the meaning of *oderiferous*. The intervention modeled a flexible, analytical approach to using bound roots for morphological problem solving.

Although we found positive, significant treatment effects on establishing meaning representations in memory for bound roots in both sixth and seventh grades, the magnitude of the effects might seem to undermine their significance, given that intervention students recalled the meaning of bound roots only about 25% of the time, on average. Yet, our findings suggest that even in the absence of firm representations for the meanings of bound roots, students were able to develop metalinguistic awareness of the roots to a useful level. Evidence for this metalinguistic awareness surfaced in two ways. First the large, positive treatment effect on the comprehension dimension indicated that the intervention supported metalinguistic insight into how bound roots could be applied to infer word and sentence meanings. Second, students' recognition of roots and recall of their meanings did not influence the degree to which students were able to apply the morphological information to support comprehension, when controlling for prior reading achievement and instructional condition, as predicted by our final regression model.

Further indications of the nuanced role of roots were evident in the qualitative examination of students' responses to the Morphological Analysis Task, which revealed how students from all conditions approached the task of applying information about Latin roots to infer word meaning and reach comprehension. We found that control students who not only did not have much success in recognizing roots, but had never been introduced to bound roots, still showed some success in inferring meanings of words with bound roots in context, within a supportive task.

Qualitative analysis also revealed that students were able to apply bound Latin roots directly, as well as use the indirect approach observed in prior research (Anglin, 1993; Goodwin & Pacheco, 2013). That is, students determined word meanings via either the bound root itself ("voc" to *vociferous*) or via a word containing the bound root (*vocal* or *vocabulary* to *vociferous*). Students who had experienced the intervention were more likely to take the direct approach. These efforts had varying degrees of success, as in some cases direct application of the root only got students to a "ballpark" understanding. Yet even when students do not reach a completely accurate interpretation of the context at hand, getting into the "ballpark" may well be beneficial. Consider that under natural conditions while reading connected text, students can marshal knowledge about Latin roots in combination with broader contextual information to support comprehension. In fact, Baumann and colleagues (2003) found that calling on both contextual and morphological information is precisely what students did to bolster comprehension in their study.

Analyzing an unfamiliar word indirectly by using a word that appeared to be morphologically related was also a strategy that met with mixed success. Using a familiar word that shared the target word's root as the unit of analysis often led to success in understanding the context. However, students sometimes chose a word that did not, in actuality, share the Latin root, which led to inaccurate interpretation of the contexts. In other cases, students used the root-related RAVE word that was presented in the task as their unit of analysis, but equated the meaning of the entire RAVE word with the root, which also led to imprecise or inaccurate understanding of the context.

Another dimension of the complexity of applying bound roots that our qualitative examination of responses brought to light was the importance of flexibility in morphological problem solving. Students were more successful when they took a "brainstorming" approach, forming, abandoning, and re-forming hypotheses as information accumulated. Students using this approach were not derailed by consideration of words that turned out to have no morphological relation to the target word, but were able to change

paths and use subsequent information supplied in the task to reach appropriate conclusions. In contrast, making erroneous connections between roots and words posed problems in reaching an understanding of the context for students who lacked flexibility in their approach.

Limitations

We acknowledge a number of limitations to the study, some caused by necessary choices in designing instruction, others by circumstances of our implementation setting. First, the small size of the study is one obvious limitation to drawing conclusions. Second, our ability to compare across the two years of the study was limited both by slight variation in the task across the two years and difference in design due to the separation of the honors students, necessitating different statistics (i.e., partial η^2 to measure treatment effect with two groups in sixth grade and Cohen's d to measure treatment effect with three groups in seventh grade).

Dosage of morphological instruction was limited, as this aspect was but a small piece of a larger project. Intervention students received 11 lessons (seven in sixth grade; four in seventh grade) in which they learned to analyze the meaning relations between words containing shared roots, and typically, each root was addressed in only one lesson. Thus our results can say little about the extent of the effects of such instruction, but do raise the potential of its utility.

Implications

The value of instruction about derivational affixes is relatively well-established. It has been shown that knowledge of stem-words and affixes contribute to knowing the meaning of morphologically complex words (Nagy, Carlisle, & Goodwin, 2014). While evidence for instruction on morphological analysis using bound roots is much more limited, the present study suggests that students might benefit from expanding their morphological problem solving toolbox by receiving instruction about bound Latin roots.

RAVE morphology instruction engaged students in analyzing the relationship between a word and its bound root, and then challenged students to explain the relationship between roots and other words containing those roots. The instruction was integrated into a vocabulary program and taught students to take a problem-solving approach, features recommended by Bowers and colleagues (2010). However, the instruction did not guide students to use root knowledge to analyze words within a context, such as exemplified in the dynamic assessment. A productive direction for future research might be to follow explicit instruction in root meanings with analysis of words in context that contain those roots. Such analysis might occur during spontaneous opportunities, such as when related words appear in classroom reading materials or in the school environment.

Although differences in treatment effects between sixth and seventh grades could not be compared directly, our results suggest that two years of instruction did have more of an impact on the comprehension dimension compared to one year. This could imply that it is worth investigating instruction on a greater number of words containing target roots, with each root addressed over a longer period of time. More encounters with bound roots over a longer period of time would fit with Schreuder and Baayen's (1995) model, in which frequency of encounters is essential. Schreuder and Baayen assert that the mechanism for learning the meanings of bound roots is frequency of encounters, arguing that, "if a particular pattern occurs often enough, a concept node is created for this pattern" (p. 144).

Our findings imply that success in morphological analysis requires more than recognition of roots and knowledge of their meanings, as students' spontaneous recall of roots meanings had no bearing on their ability to use information for morphological analysis. This highlights metalinguistic awareness as a key piece of the ability to utilize morphological information.

Flexibility in applying Latin roots appeared to be a dimension of success in morphological analysis. This implies that flexibility in using morphological analysis should serve as a central principle in instruction, as the relationship between Latin roots and the meanings of words containing those roots is often historically shaped and distant. Integrating across our findings leads us to conjecture that a flexible,

problem-solving stance, combined with extensive, analytical instruction about carefully selected Latin roots may provide effective enhancement to students' vocabulary development. Moreover, instruction that is designed to provide guided encounters with roots to illustrate not only their meanings but also the range of phonological and orthographic forms might support flexible morphological analysis.

Beyond the boost to comprehension afforded by inferring meanings of unfamiliar words that we observed in the dynamic assessment, we anticipate that the benefits of instruction in Latin roots could extend farther. Instruction about bound roots might strengthen mental representations for the instructed words by providing more connections to a word's semantic and orthographic features. It is possible that instruction focused on morphological analysis of roots might strengthen semantic networks between words, leading to more precise, enriched representations of word meanings in memory (Bowers, Kirby, & Deacon, 2010), which may support comprehension.

In closing, this study presents important, albeit preliminary, evidence that some words previously considered poor candidates for morphological analysis may in fact be accessible. It may be that students can acquire generalizable knowledge about bound roots that will enable them to get the meanings of these words with limited contextual support. Such roots from the Latinate layer of English may facilitate efficient acquisition of new word meanings of the academic lexis that students will likely encounter in secondary school and university-level texts.

Acknowledgments

We gratefully acknowledge Nancy Artz, Michelle Rimby, Cheryl Sandora, and Shelley Tavis for their contributions to data collection. We are thankful to Mr. Raymond Morton for his support of this research. Finally, we would like to thank the anonymous reviewers for the many substantive comments and suggestions that led to extensive improvements in the article. This work would not be possible without the partnership of administrators, educators, and students in our collaborating school district.

Funding

We gratefully acknowledge the Institute for Education Sciences of the U.S. Department of Education for its support of the research described in this article (Award R305A100440). The opinions expressed do not necessarily reflect those of the Institute, and no official endorsement should be inferred.

Notes

1. *Semantic transparency* is defined as the degree to which the relationship between the word and root meanings can be readily inferred, and was informed by Goodwin, Gilbert, and Cho's (2013) adaption of Nagy and Anderson's (1984) semantic transparency scale. For example, the relation between *vert* (change) and *divert* (change directions) may arguably be more easily detected than the relation between an opaque bound root such as *riv* (from rivus meaning "stream") and *derive*, though the relationship is understandable if one learns about the etymology of *derive*.
2. *Phonological transparency* is defined as whether the pronunciation of the bound root is intact in the words in which it appears, as informed by Carlisle and Stone (2005).
3. *Orthographic stabilty* is defined as whether the spelling of the bound root is intact in the words in which it appears, as informed by Carlisle and Stone's definition of "orthographic transparency" (2005).
4. Becker's corpus identifies all morphographs in the 26,000 highest frequency words in English. Becker and colleagues identified 6,531 total "morphographs"—that is bound roots and all stem-words and their derivations. Of these, approximately half appeared only once in the corpus; 2,000 appeared in three to five words; 1,500 appeared in six or more words, and 800 appeared in 10 or more words.

References

Anglin, J. M. (1993). Vocabulary development: A morphological analysis. *Monographs of the Society of Research in Child Development*, *58*(10), 1–186.

Bar-ilan, L., & Berman, R. A. (2007). Developing register differentiation: the Latinate-Germanic divide in English. *Linguistics*, *45*(1), 1–35. doi:10.1515/LING.2007.001.

Baumann, J. F., Edwards, E. C., Boland, E. M., Olejnik, S., & Kame'enui, E. J. (2003). Vocabulary tricks: Effects of instruction in morphology and context on fifth-grade students' ability to derive and infer word meanings. *American Educational Research Journal*, *40*(2), 447–494.

Baumann, J. F., Edwards, E. C., Font, G., Tereshinski, C. A., Kame'enui, E. J., & Olejnik, S. (2002). Teaching morphemic and contextual analysis to fifth-grade students. *Reading Research Quarterly*, *37*, 150–176.

Baumann, J. F., Kame'enui, E. J., & Ash, G. E. (2003). Research on vocabulary instruction: Voltaire redux. In J. Flood, D. Lapp, J. R. Squire, & J. M. Jensen (Eds.), *Handbook of research on teaching the English language arts* (pp. 752–785). Mahwah NJ: Erlbaum & Associates.

Becker, W. C., Dixon, R., & Anderson-Inman, L. (1980). *Morphographic and root word analysis f 26,000 high frequency words*. Technical Report 1980-1. University of Oregon Follow Through Project. Eugene, Oregon.

Bowers, P. N., & Kirby, J. R. (2010). Effects of morphological instruction on vocabulary acquisition. *Reading and Writing*, *23*, 515–537. doi:10.1007/s11145-009-9172-z.

Bowers, P. N., Kirby, J. R., & Deacon, S. H. (2010). The effects of morphological instruction on literacy skills: A systematic review of the literature. *Review of Educational Research*, *80*(2), 144–179.

Burton, V. J., & Watkins, R. V. (2007). Measuring word learning: Dynamic versus static assessment of kindergarten vocabulary. *Journal of Communication Disorders*, *40*, 335–356.

Carlisle, J. F. (2000). Awareness of the structure and meaning of morphologically complex words: Impact on reading. *Reading and Writing: An Interdisciplinary Journal*, *12*, 169–190.

Carlisle, J. F. (2003). Morphology matters in learning to read: A commentary. *Reading Psychology*, *24*, 291–322. doi:10.1080/02702710390227369.

Carlisle, J. F. (2010). Effects of instruction in morphological awareness on literacy achievement: An integrative review. *Reading Research Quarterly*, *45*(4), 464–487.

Carlisle, J. F., & Stone, C. A. (2005). Exploring the role of morphemes in word reading. *Reading Research Quarterly*, *40*, 428–449.

Carnegie Council on Adolescent Literacy. (2010). *Time to act: An agenda for advancing adolescent literacy for college and career success*. New York, NY: Carnegie Corporation of New York.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Corson, D. (1997). The learning and use of academic English words. *Language learning*, *47*(4), 671–718.

Coxhead, A. (2000). A new academic word list. *TESOL Quarterly*, *34*(2), 213–238.

Dale, E., & O'Rourke, J. (1981). *The living word vocabulary*. Chicago, IL: World Book.

Deak, G. O., (2003). The development of cognitive flexibility and language abilities. *Advances in Child Development and Behavior*, *31*, 271–327. doi:10.1016/s0065-2407(03)31007-9.

Deane, P. (2014). *What should the vocabulary construct be*? Paper presented at Collaborative Conference to Expand and Reimagine the Nature of Vocabulary Assessment. Educational Testing Service: Princeton, NJ.

Foorman, B. R., Petscher, Y., & Bishop, M. D. (2012). The incremental variance of morphological knowledge to reading comprehension in grades 3–10 beyond prior reading comprehension, spelling, and text reading efficiency. *Learning and Individual Differences*, *22*(6), 792–798.

Goodwin, A. P., Gilbert, J. K., & Cho, S.-J. (2013). Morphological contributions to adolescent word reading: An item response approach. *Reading Research Quarterly*, *48*(1), 39–60.

Goodwin, A. P, Gilbert, J. K., Cho, S. J., & Kearns, D. M. (2014). Probing lexical representations: Simultaneous modeling of word and person contributions to multidimensional lexical representations. *Journal of Educational Psychology*, *106*(2), 448–468. doi:10.1037/a0034754.

Goodwin, A. P., & Ahn, S. (2010). A meta-analysis of morphological interventions: Effects on literacy achievement of children with literacy difficulties. *Annals of Dyslexia*, *60*, 183–208.

Goodwin, A. P., & Ahn, S. (2013). A meta-analysis of morphological interventions in English: Effects on literacy outcomes for school-age children. *Scientific Studies of Reading*, *17*(4), 257–285.

Goodwin, A. P., & Pacheco, M. B. (2013). *Rooting out meanings: An examination of morphological problem-solving strategies used by adolescent readers in different word-solving contexts*. Paper presented at the 2013 Annual Meeting of the American Educational Research Association, San Francisco, CA.

Kemp, N. M. (2006). Children's spelling of base, inflected, and derived words: Links with morphological awareness. *Reading and Writing*, *19*(7), 737–765.

Kirk, C., & Gillon, G. T. (2009). Integrated morphological awareness intervention as a tool for improving literacy. *Language, Speech, and Hearing Services in Schools*, *40*, 341–351.

Leong, C. K. (2000). Rapid processing of base and derived forms of words and grades 4, 5 and 6 children's spelling. *Reading and Writing: An Interdisciplinary Journal*, *12*, 277–302. Dordrecht, the Netherlands: Kluwer Academic Publishers.

Lubliner, S., & Hiebert, E. (2011). An analysis of English-Spanish cognates as a source of general academic language. *Bilingual Research Journal*, *34*, 76–93.

MacGinitie, W. H., MacGinitie, R. K., Maria, K., & Dreyer, L. G. (2000). *Gates-MacGinitie reading tests* (4th ed.). Rolling Meadows, IL: Riverside Publishing.

McCutchen, D., & Logan, B. (2011). Incidental word learning: Children's strategic use of morphological information to infer word meanings. *Reading Research Quarterly*, *46*, 334–349.

McCutchen, D., Logan, B., & Biangardi-Orpe, U. (2009). Making meaning: Children's sensitivity to morphological information during word reading. *Reading Research Quarterly*, *44*(4), 360–376.
McCutchen, D., & Stull, S. (2015). Morphological awareness and children's writing: accuracy, error, and invention. *Reading and Writing*, *28*, 271–289. doi:10.1007/S11145-014-9524-1.
McKeown, M. G. (1985). The acquisition of word meaning from context by children of high and low ability. *Reading Research Quarterly*, *20*(5), 482–496.
McKeown, M. G., Beck, I. L., Omason, R. C., & Pople, M. T. (1985). Some effects of the nature and frequency of vocabulary instruction on the knowledge and use of words. *Reading Research Quarterly*, *20*(5), 522–534.
McKeown, M. G., Crosson, A. C., Artz, N. J., Sandora, C., & Beck, I. L. (2013). In the media: Expanding students' experience with academic vocabulary. *The Reading Teacher*, *67*(1), 45–53.
Nagy, W. E., & Anderson, R. C. (1984). How many words are there in printed school English? *Reading Research Quarterly*, *19*, 304–330.
Nagy, W. E., Anderson, R. C., Schommer, M., Scott, J. A., & Stallman, A. C. (1989). Morphological families in the internal lexicon. *Reading Research Quarterly*, *24*(3), 262–282
Nagy, W. E., Berninger, V. W., & Abbott, R. D. (2006). Contributions of morphology beyond phonology to literacy outcomes of upper elementary and middle-school students. *Journal of Educational Psychology*, *98*(1), 134–147.
Nagy, W. E., Berninger, V., Abbott, R., Vaughan, K., & Vermeulen, K. (2003). Relationship of morphology and other language skills to literacy skills in at-risk second grade readers and at-risk fourth grade writers. *Journal of Educational Psychology*, *95*(4), 730–742.
Nagy, W. E., Carlisle, J. F., & Goodwin, A. P. (2014). Morphological knowledge and literacy acquisition. *Journal of Learning Disabilities*, *47*(1), 3–12.
Nagy, W. E., & Hiebert, E. (2011). Toward a theory of word selection. In M. L. Kamil, P. D. Pearson, E. B. Moje, & P. P. Afflerbach (Eds.), *Handbook of reading research* (Vol. IV, pp. 388–404). New York: Routledge.
Nagy, W. E., & Scott, J. A. (2000). Vocabulary processes. In M. L. Kamil, P. B. Mosenthal, P. David Pearson, & R. Barr (Eds.), *Handbook of reading research* (Vol. III, pp. 69–284). Mahwah, NJ: Erlbaum.
Nagy, W. E., & Townsend, D. (2012). Words as tools: Learning academic vocabulary as language acquisition. *Reading Research Quarterly*, *47*(1), 91–108.
National Reading Panel. (2000). *Teaching children to read: An evidence-based assessment of the scientific literature on reading and its implications for reading instruction* (NIH Publication No. 00-4754). Washington, DC: National Institutes of Health.
Pacheco, M. B., & Goodwin, A. P. (2013). Putting two and two together: Middle school students' morphological problem-solving strategies for unknown words. *Journal of Adolescent & Adult Literacy*, *56*(7), 541–553. doi:10.1002/jaal.181
Pearson, P. D., Hiebert, E. H., & Kamil, M. (2012). Vocabulary assessment: Making do with what we have while we create the tools we need. In J. Baumann and E. Kame'enui (Eds.), *Vocabulary instruction: Research to practice* (2nd ed., pp.231–255) New York, NY: Guilford Press.
Poehner, M. E., & Lantolf, J. P. (2010). Vygotsky's teaching-assessment dialectic and L2 education: The case for dynamic assessment. *Mind, Culture, and Activity*, *17*, 312–330. doi:10.1080/10749030903338509.
Schreuder, R., & Baayen, R. H. (1995). Modeling morphological processing. In L. B. Feldman (Eds.), *Morphological aspects of language processing* (pp. 131–154). Hillsdale, NJ: Lawrence Erlbaum Associates.
Scott, W. A. (1962). Cognitive complexity and cognitive flexibility. *American Sociological Association*, *25*(4), 405–414. doi:10.2307/2785779
Singson, M., Mahony, D., & Mann, V. (2000). The relation between reading ability and morphological skills: Evidence from derivational suffixes. *Reading and Writing: An Interdisciplinary Journal*, *12*, 219–252. Netherlands: Kluwer Academic Publishers.
Snow, C. E., & Uccelli, P. (2009). The challenge of academic language. In D. R. Olson & N. Torrance (Eds.), *The Cambridge handbook of literacy* (pp. 112–133). Cambridge, England and New York, NY: Cambridge University Press.
Stahl, S. A., & Fairbanks, M. M. (1986). The effects of vocabulary instruction: A model-based meta-analysis. *Review of Educational Research*, *56*(1), 72–110.
Townsend, D., Fillipini, A., Collins, P., & Biancarosa, G. (2012). Evidence for the importance of academic word knowledge for the academic achievement of diverse middle school students. *Elementary School Journal*, *112*, 497–518.
Tyler, A., & Nagy, W. (1989). The acquisition of English derivational morphology. *Journal of Memory and Language*, *28*, 649–667.
Wagner, R. K., Muse, A. E., & Tannenbaum, K. R. (2007). Promising avenues for better understanding implications of vocabulary development for reading comprehension. In R. K. Wagner, A. E. Muse, & K. R. Tannenbaum (Eds.), *Vocabulary acquisition: Implications for reading comprehension* (pp. 276–291). New York, NY: Guilford Press.
Werner, H. (1954). Change of meaning: A study of semantic processes through the experimental method.. *The Journal of Psychology*, *50*, 181–203.
Werner, H., & Kaplan, E. (1950). The acquisition of word meanings: A developmental study. *Monographs of the Society of Research in Child Development*, *15* (1, Serial No. 51), 1–120.
Zeno, S. M., Ivens, S. H., Millard, R. T., & Duvvuri, R. (1995). *The educator's word frequency guide*. Brewster, NY: Touchstone Applied Science.

Appendix 1.

Sample items from the morphological awareness task

Sample Item from Sixth Grade

Latin root: min (less, small)

Show the student the sentence, and read it aloud to the student.

Most of their conversations were about the minutiae of daily life.

What does that mean about their conversations? What makes you think that?

Go on to the next item if the student both 1) mentions the word part min; and 2) explains the connection between its meaning and the sentence.

Look at the word minutiae. Do you see a word part that you recognize?

If student is unable to identify the word part or gives a response other than min, highlight the part min.

What does that word part mean?

If student doesn't know what the word part means, show them the word diminish and remind them that when something is diminished there is less of it.

Min comes from a Latin word that means "small."

So, does that give you any other ideas about their conversations?

OK, let's look at another one.

Sample Item from Seventh Grade

Latin root: voc (speak, call)

Show the student the following sentence strip, and read it aloud to the student.

Out in the street there was a vociferous crowd.

What is this saying about the crowd? What makes you think that?

Go on to the next item if the student both 1) mentions the word part voc; and 2) explains the connection between its meaning and the sentence.

Look at the word vociferous. Do you see a word part that you recognize?

After the student responds (correctly or incorrectly), circle the word part voc.

What does this word part mean?

If the student doesn't know what the word part means, show them the sentence strip with the words vociferous and advocate, underline "voc" in both words, and remind them that when someone advocates for a person or an idea it means that they speak up in favor of them.

Does that help you remember what voc means?

Confirm or remind: **Voc comes from a Latin root that means "speak" or "call."**

So, does that give you any other ideas about the crowd?