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The Impact of Word Knowledge Instruction on Literacy Outcomes in Grade 5

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The Impact of Word Knowledge Instruction on Literacy Outcomes in Grade 5

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District leaders in a large urban school district in central Florida wanted to examine the efficacy of a new curriculum designed to enhance the word knowledge of grade 5 students so as to improve reading achievement. The new curriculum, called Word Knowledge Instruction (WKI), consists of 15-minute lessons 4 days a week for 20 weeks. The lessons address state standards and cover 20 prefixes and suffixes. Thirty-nine schools participated in the study, with 92 English language arts (ELA) teachers in high-poverty schools randomly assigned within schools either to use WKI or to continue to use their standard ELA curriculum. Classroom observations revealed that WKI was implemented as intended. WKI had a positive effect, equivalent to an increase of 9 percentile points, on students' ability to correctly extract and spell a base word from a derived word, one of the skills explicitly taught by WKI. WKI had no effect on two other related reading skills that were not directly taught by WKI (students' ability to select a nonword that best fits the grammatical context of a sentence or to use knowledge of word parts to infer meaning of new words) or on students' vocabulary or reading scores. These findings suggest that, although students learned what they were explicitly taught, the transferability to related but not directly taught skills might require more intense or longer duration instruction or additional professional development for teachers.

Why this study?

Reading scores on the National Assessment of Educational Progress (NAEP) in grades 4 and 8 declined between 2017 and 2019 in most U.S. states. The trajectory of reading scores had remained flat since the inception of NAEP in 1992, but in recent years the gap between lower-performing students and higher-performing students has begun to increase (McFarland et al., 2019). Although NAEP reading scores increased slightly for English learner students in grade 4 (from 189 in 2017 to 191 in 2019 on a scale of 0–500), scores were still below the basic proficiency level (U.S. Department of Education, 2019). These results were mirrored in the large urban school district in central Florida covered in this study.

The Florida school district leaders wanted to examine the efficacy of a new instructional program designed to enhance the word knowledge of grade 5 students and improve their reading achievement, especially for English learner students. The grade 5 English language arts (ELA) curriculum includes complex text with social studies content. District leaders wanted strategies for deepening students' knowledge of multisyllabic words in informational text, such as in science and social studies. Additionally, the district wanted the strategies to better address the research findings and the state standards on teaching morphological awareness—knowledge of Greek and Latin roots, base words, prefixes, and suffixes—to help students in the upper elementary and middle school grades infer the meaning of new words and expand their vocabulary (Lesaux et al., 2014; see box 1 for definitions of key terms). Nearly 70 percent of academic terms have Latin roots (Scott et al., 2012), and it is estimated that the meaning of 60 percent of novel words can be deduced by morphological analysis and linguistic context (Nagy & Anderson, 1984).

In response to a request from district leaders, the Regional Educational Laboratory Southeast tested the impact of a classroom instructional program, Word Knowledge Instruction (WKI; Wood & Bustamante, 2017), that was intended to increase morphological awareness by making students aware of the minimal

For additional information on technical methods, access the report appendix at https://go.usa.gov/xsAkf.

units of meaning in multisyllabic words (base and root words and affixes that can be added to create new words) as a strategy to build word knowledge. Morphological awareness is thus a building block to constructing word and sentence understanding. WKI was employed in grade 5 ELA in 39 of the district's high poverty, low-performing elementary schools in the 2018/19 school year. WKI consists of 15-minute lessons taught 4 days a week for 20 weeks to the entire ELA class. Each week of WKI lessons focuses on a single affix (prefix or suffix), covering 20 affixes in all. WKI lessons explicitly teach morphological awareness by deconstructing and constructing words; composing sentences; discussing the meaning of words presented in connected text; defining words, pairing them with synonyms, and linking them to existing knowledge; contrasting base words with new words derived by adding affixes; and creating family trees by adding affixes to base and root words. (A more detailed description of WKI is in appendix A.)

Box 1. Key terms

Affixes. A word element (morpheme) added to the beginning or end of a base or root word to form a new word. Prefixes are added to the beginning of a base or root word, and suffixes are added to the end of a base or root word.

Control group or condition. Study participants who do not receive the experimental treatment. In this study the control group received the business-as-usual English language arts curriculum taught to all grade 5 students.

Decomposition or real-word decomposition. Extracting a base word, such as *complex,* from a word that contains that base word, such as *complexity*.

Florida Standards Assessment English Language Arts (FSA–ELA). The annual standards-based, criterion-referenced English language arts assessment that is used to measure student proficiency on the state's English language arts standards. Scores on the FSA–ELA are reported as a developmental scale score and range from 240 to 412.

i-Ready Reading assessment and i-Ready Vocabulary subtest. Computer-adaptive multiple-choice reading assessment for grades K–12, which are administered three times a year: in the fall (late August), winter (early December), and spring (early April). The i-Ready Reading composite score comprises the Vocabulary, Informational Text Comprehension, and Literacy Text Comprehension subtests. The i-Ready Vocabulary task assesses students on academic and domain-specific vocabulary, word relationships, word-learning strategies, prefixes, suffixes, word roots, and use of reference materials. The i-Ready Reading assessment administered in August 2018 was used as the pretest for the short-term outcomes in the study. The i-Ready Vocabulary subtest administered in August 2018 was used as the pretest for the long-term vocabulary outcome (i-Ready Vocabulary subtest) administered in April 2019.

Inferencing of word meanings. Selecting a synonym from four answer choices for a word containing a taught affix with an unfamiliar base word presented in a sentence taken from an academic passages. For example, given the adjectival affix –ed and the sentence "Eagles are very *skilled* hunters," the student can select *experienced* from among the other three choices of *clumsy, scheduled*, and *talent*.

Long-term measures or outcomes. The measure or outcomes used by the study to assess the long-term effects of Word Knowledge Instruction on vocabulary and reading comprehension: i-Ready Vocabulary subtest and the FSA–ELA.

Morphological awareness. An understanding of the minimal units of meanings in a word—base word, root word, prefix, or suffix—and how these units can be combined to form a new word.

Nonword derivation. Choosing a nonword that best fits the grammatical context of a sentence. For example, given the spoken sentence "The man is a great ___," the student can select *tranter* from among the other three answer choices of *tranting*, *trantitious*, and *trantiful*.

Short-term measures or outcomes. The three researcher-developed measures or outcomes of morphological awareness used in the study to assess the short-term effects of Word Knowledge Instruction: real-word decomposition, nonword derivation, and inferencing of word meanings.

Student demographic characteristics. Used as covariates in the analysis, the study used data on three student demographic characteristics: eligibility for the national school lunch program, English learner student status, and race/ethnicity.

Treatment group or condition. Study participants who receive the experimental treatment. In this study the treatment group received Word Knowledge Instruction, an instructional program intended to increase morphological awareness by teaching students about the minimal units of meaning in multisyllabic words (base word, root word, and affixes that can be added to create new words) as a strategy to build word knowledge. In this study Word Knowledge Instruction (WKI) was employed in grade 5 ELA in 42 of the district's high poverty, low-performing elementary schools in the 2018/19 school year. WKI consists of 15-minute lessons taught 4 days a week for 20 weeks to the entire ELA class, with each week focusing on a single prefix or suffix.

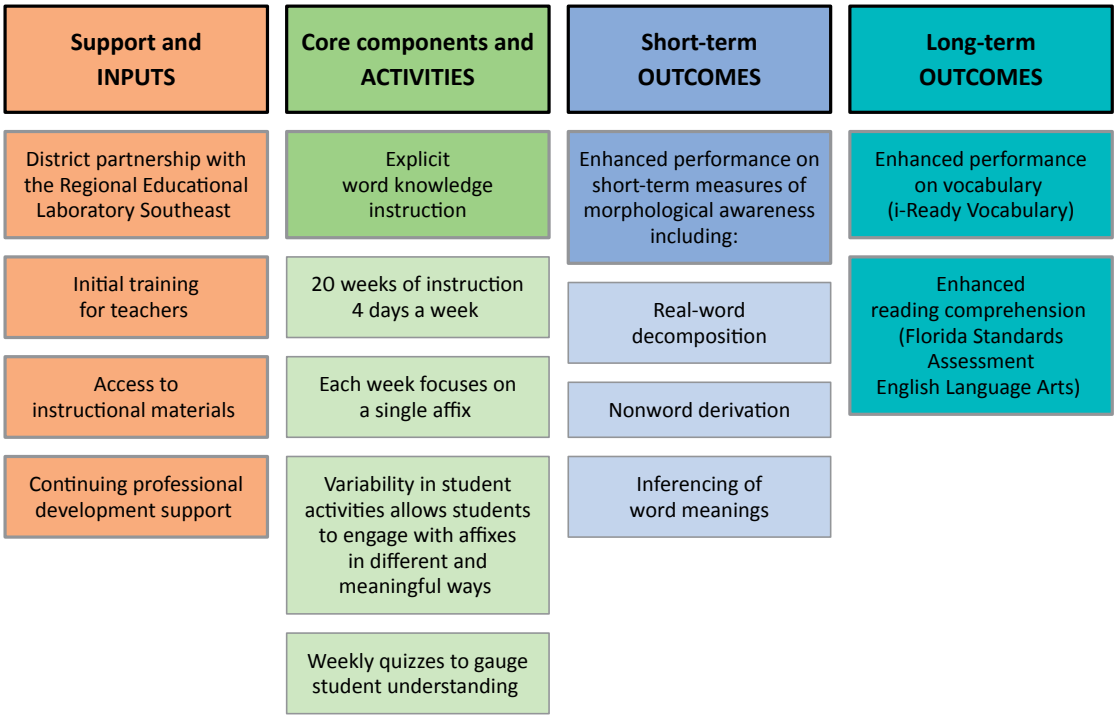
The study compared the short- and long-term outcomes for students whose teachers provided the WKI instructional program as part of their ELA program block (treatment condition) with the outcomes for students whose teachers' ELA instructional materials included the district's state-adopted core reading program materials (the business-as-usual control condition). That program included instruction on affixes, including 16 affixes that also appeared in WKI lessons. However, whereas the WKI program included explicit instruction on morphological awareness in four lessons on each affix, the district's core ELA program materials included only one lesson on affixes and emphasized vocabulary learning. Because WKI supplemented rather than replaced the district's core curriculum, students in the treatment group likely received most of the instruction on affixes that students in the control group received, plus the extra content offered by WKI. (A more detailed description of how WKI compares to business-as-usual is presented in appendix A.)

As depicted in the logic model (figure 1), core components of WKI are hypothesized to improve both short-term and long-term outcomes by enhancing word knowledge and thereby improving vocabulary and reading comprehension. To test WKI's efficacy, short-term outcomes of enhanced word knowledge were operationalized by three researcher-developed measures of morphological awareness: real-word decomposition, nonword derivation, and inferencing of word meanings. The real-word decomposition measure requires students to extract the base word from a derived word (for example, extracting *public* from *publicity*). The nonword derivation measure requires students to select a nonword that best fits a grammatical context (for example, *tranter* from among answer choices of *tranting*, *trantitious*, and *trantiful* to complete the sentence "The man was a great _____."). The inferencing of word meanings measure requires students to select a synonym for a highlighted word included in a sentence taken from passages in the core reading program. The long-term outcome of improved vocabulary and reading comprehension was assessed using the i-Ready Vocabulary subtest and the state ELA assessment, the Florida Standards Assessment English Language Arts (FSA–ELA).

Although WKI had not been evaluated before this study, a similar intervention that included 20 weeks of 45 minutes a day whole-class word knowledge instruction for grade 6 students in California had been evaluated through a randomized controlled trial (Lesaux et al., 2014). The study found significant effects on word knowledge outcomes and on a standardized writing test (but not on a standardized reading test) that were similar to the short-term outcomes used in the current study. WKI is similar to the intervention in the California schools in that high-utility words embedded in text were taught in relation to other words, and students were given opportunities to practice the words through reading, writing, listening, and speaking. The emphasis in both interventions is on teaching students to be aware of the morphological units in words as a strategy for building word knowledge. Although both interventions lasted 20 weeks, the California intervention was more time intensive; it was used for 45 minutes a day five days a week, whereas WKI was used for 15 minutes a day four days a week.

Grade 5 ELA teachers were randomly assigned within 42 participating schools to implement WKI (53 teachers) or continue with business-as-usual ELA instruction (43 teachers). WKI developers trained the teachers in the WKI program over two and a half days in summer 2018 and provided ongoing support throughout the 20 weeks that WKI was implemented. (See box 2 for an overview of the study data, sample, and methods and appendix A for details.)

Figure 1. Logic model for Word Knowledge Instruction study



Source: Authors' compilation.

Research questions

The study addressed three research questions on the impact of WKI for grade 5 students attending 42 high-poverty schools during 2018/19:

1. What is the impact of WKI on researcher-developed, short-term measures of morphological awareness (as measured by scores on real-word decomposition, nonword derivation, and inferencing of word meanings)?

2. What is the impact of WKI on long-term measures of vocabulary and reading comprehension (as measured by scores on i-Ready Vocabulary and the FSA–ELA)?

3. Do the effects on short-term measures of morphological awareness or long-term measures of vocabulary and reading comprehension differ for English learner students?

Research question 3 was exploratory only because of the small number of English learner students in some schools.

Box 2. Data sources, sample, implementation, and methods

Data sources. This study used data from both primary and secondary sources. Primary data consisted of researcher-developed measures of student short-term outcomes for assessing morphological awareness (performance on real-word decomposition, nonword derivation, and inferencing of word meanings) that was administered by participating teachers in spring 2019. Although the researcher-developed measures were based in part on material covered by WKI, they were not considered to be strongly aligned to material covered by WKI. All the researcher-developed assessment questions in real-word decomposition and inferencing of word meanings were based on the affixes taught in WKI, though most of those affixes could have been covered in the core reading program as well. Some questions for nonword derivation were also based on suffixes taught in WKI. While the affixes covered by the measures of short-term outcomes overlapped with those covered by WKI, the questions in the researcher-developed assessment differed in important ways. In particular, the base words covered in the real-word decomposition questions and the nonsense base words in the nonword derivation questions were not covered in WKI. Similarly, the sentences used for the inferencing of word meanings questions were taken from the district's core reading program. For these reasons the measures are not considered to be strongly aligned to material covered by WKI. Appendix A discusses these measures in more detail.

The secondary data consisted of administrative data from the participating district for students whose parents consented to their participation in the study, including demographic characteristics, i-Ready Reading scores, and assessments of long-term outcomes (i-Ready Vocabulary subtest scores and Florida Standards Assessment English Language Arts [FSA–ELA] scores).[1]

Data on student performance on i-Ready Reading and i-Ready Vocabulary subtest were provided to the study team for the 2018/19 school year. The i-Ready Reading scores from the first administration, which took place in late August 2018, served as the pretest for the researcher-developed, short-term outcomes (real-word decomposition, nonword derivation, and inferencing of word meanings). This pretest measure was chosen because, among the highly correlated potential pretest measures, i-Ready Reading had the highest correlation with the short-term outcomes (see table A3 in appendix A; see appendix A for more details regarding these measures). The i-Ready Vocabulary scores from the first administration (August 2018) served as the pretest for the last administration of i-Ready Vocabulary (April 2019), which served as the posttest for the long-term vocabulary outcome. Data on student performance on the late spring administration of the FSA–ELA were provided to the study team for the 2017/18 and 2018/19 school years, with the 2017/18 administration serving as the pretest for the 2018/19 administration, which served as the posttest for the long-term outcomes.

Sample. During the 2018/19 school year grade 5 English language arts (ELA) teachers in each participating school were randomly assigned either to teach Word Knowledge Instruction (WKI, the treatment condition) or to teach their standard word-study lessons (business-as-usual control condition).[2] Among the 42 participating schools, 53 ELA teachers and 1,967 grade 5 students were assigned to the WKI group and 43 ELA teachers and 1,551 grade 5 students were assigned to the business-as-usual control group. The overall attrition rates (the percentage of the target population that was not included in the analytic sample) were 7 percent for schools, 4 percent for ELA teachers, and 37 percent for students (student attrition was high because of low parent consent rates; see appendix A for more information about attrition).

The analytic sample included 39 schools, 92 ELA teachers, and 2,214 grade 5 students (49 teachers and 1,296 students in the WKI treatment group and 43 teachers and 918 students in the business-as-usual control group).[3] Each school in the analytic sample had at least one treatment and one control teacher in the analytic sample.

Student demographic characteristics were comparable between WKI and business-as-usual samples (effect size differences ranged from 0 to 0.05; see table A6 in appendix A). Collectively, 85 percent of students were eligible for the national school lunch program (an indicator of poverty); and 20 percent were English learner students; and 54 percent of students were Hispanic, 21 percent were Black, 19 percent were White, and 6 percent were Asian or another race (including multiracial). Pretest scores were slightly higher for students in the business-as-usual control group than for students in the treatment group, but the difference was within an acceptable range to meet What Works Clearinghouse evidence standards with reservations (What Works Clearinghouse, 2020b). Effect size differences ranged from 0.06 to 0.10. (See table A5 in appendix A for more information about baseline equivalence.)[4]

Implementation. WKI developers trained WKI teachers prior to implementation, provided online access to training materials, and provided in person ongoing support, as necessary (see appendix A for more information). Students in WKI classrooms were supposed to receive WKI instruction about 15 minutes a day 4 days a week for 20 weeks. The study team conducted two classroom

observations (fall and spring) during the 20-week intervention in both treatment and control ELA classrooms using the same observation form. The observations, which lasted the full duration of the ELA instruction block, were designed to quantify the fidelity with which WKI was implemented in WKI classrooms and to determine whether WKI materials were being used in control classrooms. Implementation in WKI classrooms was assessed as adequate on the three components of fidelity: adherence to lesson sequence and script (85 percent out of 100 percent adherence, with a standard deviation of 15 percent); quality of instruction (mean of 3 on a 1–5 scale, with a standard deviation of 0.46); and lesson duration (mean of 21.32 minutes, with a standard deviation of 5.03; see table A7 in appendix A). WKI program coverage was also adequate based on completion of WKI activities in student workbooks: 47 of the 49 WKI teachers covered all 20 affixes, and 2 WKI teachers covered only 15 affixes (1 teacher went on leave mid-year and no one took over WKI in the class, and the other teacher moved through WKI more slowly). None of the teachers in the business-as-usual control group was observed using WKI materials.

Methodology. To account for the nested nature of the data (students nested in teachers and teachers nested in schools), the study team used multilevel modeling to compare student performance on measures of morphological awareness, vocabulary, and reading comprehension for students of WKI teachers and students of business-as-usual control teachers. Student-level pretest scores and demographic variables were included in the models to adjust for differences in these student characteristics between treatment and control groups. A Benjamini-Hochberg correction was conducted to account for the multiple hypothesis tests conducted (Benjamini & Hochberg, 1995). To answer exploratory research question 3, interaction terms were included in the multilevel models to identify differential impacts for English learner students. (See appendix A for more details regarding the analytic models used to estimate the impact of WKI.)

Notes

1. Performance on i-Ready Reading was not used as a long-term outcome because i-Ready Reading was highly correlated with FSA–ELA (correlation of .83), and the district was more interested in evaluating the impact of WKI on FSA–ELA.

2. In 12 schools with an odd number of participating ELA teachers, the treatment condition was randomly assigned one more teacher than the control condition.

3. Analytic sample sizes for English learner and non-English learner students by condition were as follows: the treatment group comprised 258 English learner students and 1,036 non-English learner students, and the control groups comprised 185 English learner students and 729 non-English learner students. Students who joined the classroom during the school year were excluded from all analyses.

4. Demographic data were not accessible for students without parental consent, and there was too much missing data in publicly available demographic data for participating schools to accurately estimate sample characteristics for the full population. Thus, it was not possible to determine whether students without parental consent were demographically similar to students with consent.

Findings

This section presents the main findings of the study.

Performance on real-word decomposition was significantly better for students receiving Word Knowledge Instruction than for students in the business-as-usual control group, whereas performance on nonword derivation and inferencing of word meanings was comparable

A comparison of performance between the treatment and control groups on the researcher-developed real-word decomposition task was intended to assess whether WKI resulted in significant improvements in students' ability to decompose words into their parts. Instruction focusing on decomposing words into their parts (prefix, base word, and suffix) was a central component of the WKI lessons, but decomposition was not specifically called for in the state standards or in classroom instruction in the business-as-usual control condition. Thus, a decomposition task was developed to assess students' ability to extract the base word from a word that was not taught in the WKI lessons. The comparison showed that WKI had a statistically significant positive impact on student performance on the short-term outcome of real-word decomposition (table 1). After student demographic characteristics and

initial pretest performance[1] were statistically controlled for, decomposition scores were significantly better for students in the WKI treatment group than for students in the business-as-usual control group, with an effect size of 0.23. An effect size of 0.23 is equivalent to an increase in outcome performance of 9 percentile points for an average student in the WKI treatment group compared with an average student in the control group (Lipsey et al., 2012).

WKI did not have a statistically significant impact on the two other researcher-developed short-term outcomes of nonword derivation and inferencing of word meanings, two morphological skills that are not directly taught in WKI but that affect vocabulary and, in turn, reading comprehension. The derivation task assessed a student's ability to complete a sentence by choosing the nonsense base word that had an appropriate suffix. The inferencing of word meanings task assessed a student's ability to identify a synonym for a word containing an affix presented in a sentence. After student demographic characteristics and initial pretest performance were statistically controlled for, performance on nonword derivation and inferencing of word meanings was comparable between the WKI treatment group and the business-as-usual control group (effect size of 0.05 for derivation and –0.02 for inferencing of word meanings). This suggests that students did not transfer the skills taught in WKI to these skills.

Performance in vocabulary and reading comprehension was comparable for students receiving Word Knowledge Instruction and those in the control group

Receiving WKI instruction did not have a statistically significant impact on student performance on the i-Ready Vocabulary subtest or the FSA–ELA, the long-term outcomes assessed in the study (table 1). After student demographic characteristics and initial pretest performance were statistically controlled for,[2] performance on the i-Ready Vocabulary subtest and on the FSA–ELA was comparable between the WKI treatment group and the business-as-usual control group (effect sizes of –0.01 for i-Ready Vocabulary and 0.02 for FSA–ELA).

The impact of Word Knowledge Instruction on morphological awareness, vocabulary, and reading performance was comparable for English learner students and non-English learner students

For all outcomes WKI had similar effects for English learner students and non-English learner students. After student demographic characteristics and initial pretest performance were statistically controlled for, differences in posttest scores were comparable on all short-term and long-term outcomes for English learner students and non-English learner students in the WKI treatment group and for both groups of students in the business-as-usual control group (see tables A14–A16 in appendix A).

1. The fall i-Ready Reading score was chosen as the pretest measure for the three researcher-developed, short-term outcomes because, among the highly correlated pretest measures, i-Ready Reading had the highest correlation with the short-term outcomes (see table A3 in appendix A). Pretest scores for i-Ready Reading were slightly higher for students in the control group than for students in the WKI treatment group, but the difference (effect size of 0.08) was within an acceptable range to meet What Works Clearinghouse evidence standards with reservations (What Works Clearinghouse, 2020b).
2. i-Ready Vocabulary and FSA–ELA pretest scores were slightly higher for students in the control group than for students in the WKI treatment group (effect size difference of 0.06 for i-Ready Vocabulary and 0.10 for FSA–ELA; see table A5 in appendix A), but the difference was within acceptable bounds to meet What Works Clearinghouse evidence standards with reservations (What Works Clearinghouse, 2020b).

Table 1. Adjusted posttest scores for students receiving Word Knowledge Instruction and students in the control group, 2018/19

Outcome measure	Word Knowledge Instruction treatment group		Control group		Effect size[a]
	Adjusted mean	Standard deviation	Adjusted mean	Standard deviation	
Short-term outcome					
Real-word decomposition	12.76	4.39	11.71	4.66	0.23*
Nonword derivation	9.62	3.67	8.81	3.69	0.05
Inferencing of word meanings	7.74	2.47	7.79	2.60	–0.02
Long-term outcome					
i-Ready Vocabulary	566.21	47.68	566.92	48.82	–0.01
Florida Standards Assessment English Language Arts	317.32	20.78	316.88	21.31	0.02

* Significant at $p < .001$.

Note: The adjusted means are predicted means for a student with average characteristics based on regression results (see tables A10 and A11 in appendix A for details). Total possible points are 20 for real-word decomposition, 16 for nonword derivation, and 15 for inferencing of word meanings. The sample included 49 teachers in the Word Knowledge Instruction treatment group and 43 teachers in the control group. Student-level sample sizes and unadjusted means by condition for each outcome are reported in table A12 in appendix A.

a. Following What Works Clearinghouse procedures, Hedges' *g* was used to calculate the effect sizes. See What Works Clearinghouse (2020a) for more information.

Source: Authors' analysis of school district data for 2017/18 and 2018/19.

Limitations

Before generalizing the findings of this study to other contexts, readers should note three limitations. First, Florida adopted new ELA standards in 2020. Thus, future research should examine how the revised WKI intervention differs from current practices in Florida. Second, participating schools do not represent a nationally representative sample, and therefore findings are generalizable only to schools, teachers, and students similar to those that participated in the study. Third, this study reports findings only for students whose parents consented to their participation in the study (about 77 percent). Data on student demographic characteristics (eligibility for the national school lunch program, English learner student status, and race/ethnicity) and on pretest scores were not accessible for students who did not receive parental consent to participate in the study; therefore, it was not possible to determine whether students without parental consent were demographically or academically similar to students with parental consent in the study.

Implications

Given this study's mixed findings, WKI's developers might want to explore opportunities to strengthen the program. First, they might want to consider extending the typical lesson beyond 15 minutes. That could enable more fully integrating WKI with the vocabulary and reading comprehension activities in the ELA instruction block, as was the case for the grade 6 word knowledge intervention in California assessed by Lesaux et al. (2014), which was 45 minutes long and which was found to have significant effects on word knowledge and writing outcomes. Second, although fidelity of implementation and program coverage for WKI were adequate, ratings for adherence to lesson sequence and script and of teaching quality varied among teachers. Such variability suggests that additional professional development might be needed to implement WKI with fidelity and to ensure high-quality instructional practices.

The district might want to wait for revisions to WKI such as these before implementing it in other schools. Alternatively, they could consider using other reading interventions to improve the low ELA performance of participating

schools. WKI improved students' ability to extract the base word from the form of the word that included a taught suffix and to spell the base word correctly. However, this decomposition skill did not transfer to improvements on other related measures of morphological awareness that were not directly taught or to improvements in students' vocabulary and reading comprehension.

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