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A Pilot Study of the Impact of Double-Dose Robust Vocabulary Instruction on Children's Vocabulary Growth

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Impact of Double-Dose Robust Vocabulary Instruction on Children's Vocabulary Growth

Children's vocabulary skills exhibit strong concurrent and predictive relations with their reading achievement, such that children who have well-developed vocabulary skills typically are good readers (Cain, Oakhill, & Bryant, 2004; Catts, Fey, Tomblin, & Zhang, 2002; Oakhill & Cain, 2012). At the same time, children who are poor readers, specifically those with comprehension-specific reading problems, tend to have poor vocabulary skills compared to children without such problems (Catts, Adlof, & Weismer, 2006; Justice, Mashburn, & Petscher, in press). Theoretical models of skilled reading propose that depth and breadth of vocabulary knowledge correlate with reading-comprehension skill because precise representations of word meanings and related concepts are essential for construction of a coherent and accurate mental model (Perfetti, Stafura, & Adlof, 2013).

Given the integral relations between vocabulary skill and reading ability, there have been considerable investments in developing and testing "robust" vocabulary instruction that significantly enhances both the depth and breadth of children's vocabulary skills. Robust vocabulary instruction, a term coined by Beck and colleagues, distinguishes itself from typical vocabulary instruction in that it provides children with numerous explicit and interesting experiences with academically relevant words, which contributes to deepened knowledge of these words (Isabel Beck, McKeown, & Kucan, 2002). Such instruction is also often referred to as explicit instruction. A seminal study by Beck and colleagues provided daily robust vocabulary instruction targeting deep learning of 104 words to fourth-grade students; words selected for instruction were relatively lower frequency but high-utility in that they were likely to be confronted in fourth-grade reading materials (Isabel Beck, Perfetti, & McKeown, 1982). Study

results showed that vocabulary instruction improved not only students' depth of knowledge of the targeted words, but also their semantic processing (i.e., lexical access) and general vocabulary breadth. A subsequent replication, which included experimenter-developed measures of reading comprehension, suggested that this approach to vocabulary instruction yielded positive effects on comprehension (McKeown, Beck, Omanson, & Perfetti, 1983).

In the last two decades, a large number of additional experimental studies examining the effects of various approaches to providing robust vocabulary instruction have appeared in the literature. A recent meta-analysis examined results from 67 studies testing vocabulary interventions (mean duration = 42 days) for pre-kindergarteners and kindergarteners (Marulis & Neuman, 2010). The average effect of 0.88 standard deviation units (95% CI .76 to 1.01) on vocabulary outcomes shows that these interventions tend to yield relatively large effects on children's vocabulary skills, with no difference in the size of effects across the two grades studied. Importantly, a comparison of intervention effects using explicit versus implicit approaches to improving children's vocabulary skills indicated that the former yielded consistently larger effects than the latter (1.11 vs. 0.62, respectively), and that interventions coupling both explicit and implicit approaches had the largest effects on children's vocabulary outcomes (1.21). By way of reference, an explicit approach was coded for vocabulary interventions in which words were directly defined and discussed, whereas an implicit approach was coded for those in which words were not directly defined.

An interesting aspect of the vocabulary-intervention research to date concerns how to interpret the relatively large effect sizes seen in relation to how much vocabulary skill children actually acquire. Most studies use as their primary outcome an index of children's learning of words targeted within the intervention, considered a proximal outcome, and find that children's

knowledge of these particular words grows sizably, at least as referenced by effect-size estimates. For instance, Justice and colleagues studied effects of a 10-week, 20-session vocabulary intervention delivered to 28 kindergartners at-risk for reading difficulties based on literacy-screening results; 27 students (also at-risk) comprised a control group (Justice, Meier, & Walpole, 2005). The effect-size comparison at posttest for the treatment/control comparison was 1.22 on a measure of children's knowledge of 30 words targeted during the intervention. Similar effects were seen in a study conducted by Pollard-Durodola and colleagues (Pollard-Durodola et al., 2011). Sixty-nine preschoolers participated in a 12-week daily vocabulary intervention that targeted learning of 68 academically oriented words; 56 students served as controls. The effect-size comparison at posttest for children's knowledge of 24 words, a subset of those targeted in the intervention, was 1.52 for the treatment/control comparison.

The effect-size estimates in the two afore-mentioned studies – at 1.22 and 1.52 – are considered by conventional benchmarks to be quite large, as the average effect size seen in educational interventions in the elementary grades is 0.23 (Hill, Bloom, Black, & Lipsey, 2008). However, in actuality, these effect sizes correspond to what seems to be relatively little knowledge gained. For instance, in the Pullard-Durodola study, children were tested at pre- and post-test on a 24-item multiple-choice receptive task, with each item representing a word explicitly targeted in the intervention. At pretest, children averaged 14 words correctly identified and at posttest, children averaged 21 words correctly identified, which corresponds to learning of about 7 words overall. Similar results have been reported in a number of studies (e.g., Isabel Beck et al., 1982; Biemiller & Boote, 2006; Michael Coyne, McCoach, & Kapp, 2007; Penno, Wilkinson, & Moore, 2002), suggesting that we have made little headway since 1982 when Beck and co-authors noted that students' learning of words targeted in their intervention was far less

that whey they expected: “Acquiring word meanings to a high level is not an easy task, even with intensive instruction” (p. 518). Thus, it is important to acknowledge that the generally large effect sizes seen in the vocabulary-intervention literature, averaging .88 across studies (Marulis & Neuman, 2010), do not necessarily correspond to large increases in the number of words children learn within an intervention.

In the present study, we contribute to the extant literature on the effects of robust/explicit vocabulary instruction by comparing two vocabulary-instructional conditions that are differentiated primarily in the dosage of instruction. Specifically, we sought to determine whether children’s vocabulary development could be heightened via double-dosing, in which robust vocabulary lessons were repeated to provide expanded instructional time. Double-dose instruction has been studied as an avenue for improving students’ math achievement for some time; double-dosing typically involves students taking two courses back to back, or a primary course supplemented with a “support” course (Nomi & Allensworth, 2009; Nomi & Allensworth, 2012). The premise behind double-dose instruction is straightforward: more time on task is believed to promote greater learning of content. In general, double-dose math instruction is considered an effective means for improving students’ math performance (particularly for lower-achieving students), although its application to reading-related curricula has been studied only several times and the results are mixed as to the benefits of double-dosing. On the one hand, Wanzek and Vaughn examined effects of a first-grade reading intervention delivered to struggling readers; in comparison to children who received a single-dose intervention, double-dose intervention did not significantly increase children’s reading outcomes (Wanzek & Vaughn, 2008). On the other hand, Piasta and colleagues examined effects of a pre-reading intervention delivered to preschool children, comparing effects of the intervention delivered two (single-dose)

versus four times (double-dose) per week for 30 weeks; at two-years post-intervention, those in the double-dose condition significantly outperformed those in the single-dose condition on standardized measures of reading (Piasta, Justice, McGinty, & Kaderavek, 2012).

With respect to the potential for double-dose instruction to enhance children's vocabulary skills, results here are mixed as well. Coyne and colleagues (2010) used a within-subject design to compare incidental, embedded, and extended instruction on kindergartners' learning of new words; words were randomly assigned to an incidental condition (i.e., children heard words within a read-aloud), an embedded condition (i.e., children explicitly discussed words during a read-aloud), and an extended condition (i.e., children engaged in various work with words for 15-minutes after the read-aloud). The extended condition may be considered a vehicle for double-dosing, with children receiving a support lesson following the read-aloud in which they received explicit exposure to targeted words. Children's learning of new words was significantly heightened in the extended condition as compared to both the embedded and incidental conditions (*d*s = 1.34 and 2.57, respectively, on an expressive definitions task), suggesting that having greater opportunities to engage with words can promote children's learning of these words and should be included as a key feature of vocabulary interventions. However, an earlier study provided less conclusive findings regarding the value of double-dosing in the area of vocabulary. Beck et al., in their 1982 study involving 27 fourth graders in a five-month vocabulary intervention, randomly assigned words within students to two conditions, similar to Coyne et al. Specifically, some words were assigned to a "some" condition and others were assigned to a "many" condition. Words in the some condition were targeted during daily lessons over five consecutive days, whereas those in the many condition were targeted during daily lessons over five consecutive days and then revisited repeatedly over the intervention, with

between 16 and 22 additional reviews. Although the authors indicate that the pre- to posttest difference between some and many words was significant, the difference was relatively small: on a multiple choice test examining knowledge of words in the many condition, children knew 30% accurately at pretest and 86% at posttest, compared to 31% at pretest and 78% at posttest for the some words. Put differently, at posttest children performed with 78% accuracy on some words and 86% accuracy on many words, which seems a fairly trivial distinction between the two dosage conditions.

In the present study, we considered whether increased additional time would lead to improvements in children's learning of targeted vocabulary words, using a between-group design in which children were assigned to a control group (business-as-usual classroom instruction) or two planned variations in the amount of vocabulary instruction provided, embedded within the context of a more broadly focused language-focused instructional supplement, *Let's Know!* (see Language and Reading Research Consortium, 2014). In the first variation, which we call the Basic condition, teachers implement structured vocabulary lessons (about one lesson per week) targeting 24 academically relevant words during a 21-week period of implementing *Let's Know!*. The vocabulary lessons were designed to embody those characteristics of instruction seen in many effective, robust/explicit vocabulary interventions (Isabel Beck & McKeown, 2007; Biemiller & Boote, 2006; Michael Coyne et al., 2007; Michael Coyne et al., 2010; Pollard-Durodola et al., 2011): (a) explicit discussion and defining of targeted words, (b) exposure to these words in varied contexts, including read-alouds, and (c) ongoing opportunities to elaborate the meaning of words and connections with other words via various work with words (e.g., use of graphic organizers). In the second condition, which we call the Double-Dose condition, each vocabulary lesson in the Basic condition was followed by a supplemental vocabulary support

lesson featuring additional activities to deepen children's knowledge of targeted words, similar to the extended-instruction approach described by Coyne and colleagues (2010). Two research question were addressed: (1) To what extent does robust vocabulary instruction improve pre-kindergarten through third graders' knowledge of targeted words?, and (2) To what extent does providing extended opportunities to learn targeted vocabulary words via double-dose instruction improve pre-kindergarten through third graders' knowledge of targeted words?

Given the number of studies that have appeared in the literature on the effects of vocabulary interventions over the last decades (see Marulis & Neuman, 2010), we point out two salient features of this study in addition to the explicit testing of the value of double-dose vocabulary instruction. First, this study was implemented across five grades, thus allowing us to examine the effects of robust vocabulary instruction for children from pre-kindergarten through third grade. Few studies of vocabulary intervention have included children in multiple grades, thus it is difficult to know whether robust vocabulary intervention has equivalent effects across the early primary grades. Second, this study used an innovative linking design to couple data from pre- and posttest vocabulary assessments and ongoing curriculum-based measures (CBMs) of children's vocabulary skills so as to study these over multiple time-points. Although vocabulary-intervention studies sometimes report the results of ongoing CBMs that probe children's ongoing learning of targeted words (e.g., Neuman, Newman, & Dwyer, 2011), the words probed in CBMs typically change over time, presenting a methodological challenge in using such data to model changes in children's skills over time. Here, we show how a linking design can be used to examine children's growth in targeted vocabulary words over a 21-week period of intervention implementation.

Methods

Participants

Participants in this study were 278 pre-kindergarten (pre-k) to third grade students and the lead teachers in 58 classrooms in four states across the U.S. The teachers self-selected to enroll in the study following participation in information sessions providing details of the project. Sixty-one teachers and 284 students initially enrolled in the study, but student-level pre- and posttest data were only collected in 58 classrooms due to teacher attrition. Those 58 teachers and the students in their classrooms are the focus of this investigation. The teachers (11 pre-k, 12 kindergarten, 12 first grade, 11 second grade, 12 third grade) were mostly female (95%), were generally well-educated (all had at least a Bachelor's degree), and were largely Caucasian (95%).

The families of all children in the enrolled classrooms received recruitment packets and informed consent agreements which requested permission to conduct ongoing assessments on children over the academic year. From the consents received, up to five children were randomly selected from each classroom for participation. The children (47% males, 48% females, 5% unreported) averaged 7 years of age (SD = 1.52) and ranged from four to nearly ten years of age. Children were evenly split across grades, with 46 to 60 children in each grade. In terms of race, 82% of the children were White/Caucasian, 7% were Black/African-American, 5% were Asian, 3% were American Indian or Alaskan Native (5% were other ethnicities or the information was unreported). Eight percent of the children were of a Hispanic or Latino ethnicity. Data about disabilities were missing for 21 children, but of the remaining 257 children, 11% had identified disabilities and 4% had difficulties in sensory or cognitive functioning (as reported by the caregiver). The highest level of maternal education for the participating children was fairly high, with over half (54%) of children's mothers having a bachelor's degree or higher (data missing for 18 parents).

Assignment to study conditions. Teachers were assigned to one of three conditions in this study, which represented two planned variations of a language-focused curricular supplement, *Let's Know!*, and the control condition. *Let's Know!* was designed to improve the language skills of pre-k to third-grade students as an avenue to increasing listening and reading comprehension; its development and initial pilot tests are discussed under separate cover (Language and Reading Research Consortium, in press). The two *Let's Know!* versions – Basic, Double-Dose – are differentiated primarily in the vocabulary component of instruction, which we discuss shortly.

With teacher/classroom serving as the level of assignment to condition, initial assignments were made so that there were approximately equal numbers of teachers across conditions (Basic, $n = 21$; Double-Dose, $n = 20$; and control, $n = 20$). Although random assignment would have been preferred, 20 of the participating teachers (about one-third of the sample) had participated in prior development activities, such as critiquing lesson-plan template and implementing prototype lessons. Due to their familiarity with the goals of the intervention, all of these teachers were assigned to implement *Let's Know!*, although they were randomly assigned to the Basic or Double-Dose conditions. For the remaining teachers, random assignment to the three conditions was used. Following attrition, the number of teachers per condition adjusted slightly (Basic, $n = 18$; Double-Dose, $n = 20$; and control, $n = 20$).

With assignment at the classroom level, children's condition was conditional on that of their teachers, with 86 in the Basic condition (31%), and 96 in the Double-Dose condition (35%), and 96 children (35%) in the control group. Table 1 provides a comparison of child-level characteristics across the three study conditions.

Procedures

The primary methods of relevance to this study are random assignment of teachers and children, discussed previously; teachers' implementation of the assigned study conditions; and assessment of children before, during, and after the study conditions were implemented (see *Measures*). Here, we discuss teachers' implementation of assigned study conditions, as well as methods used to monitor their implementation fidelity.

Let's Know! Conditions. Teachers assigned to implement *Let's Know!,* irrespective of version, provided 120 minutes of systematic and explicit language-focused instruction each week for 21 weeks organized into three seven-week units. (Note that a subsequent revision of the intervention added a shorter fourth unit, with total instruction lasting 26 weeks.) The three units are thematically organized to address a given topic (e.g., for pre-kindergarteners, Unit 1=Animals; Unit 2=Fiction; Unit 3=Earth Materials), and each focuses on a specific type of text-structure: compare-contrast, description, or sequence/cycles.

To implement *Let's Know!,* teachers deliver four 30-minute whole-class lessons each week. The lessons were developed to provide a systematic scope and sequence of instruction targeting children's development of language skills in four areas identified as important contributors to reading comprehension (Cain et al., 2004): vocabulary, grammar, inferencing, and comprehension monitoring. Different lesson types are used to address the four language areas; for instance, Integration Lessons target development of inferencing skills. For our purposes, children's vocabulary skills are targeted within Words to Know lessons, which are implemented in Week 1, 2, 3, and 4 in both the Basic and Double-Dose versions, as well as brief Word Review and Practice (WRAP) activities that occur multiple times during Weeks 2 to 5. Table 2 depicts the sequence of lessons, including the Words to Know lessons and WRAP sessions that comprise each unit within the two *Let's Know!* versions.

The Words to Know lessons and WRAP activities provide the mechanism for implementing robust/explicit vocabulary instruction within *Let's Know!*, and we highlight four features of this instruction. The first feature is the explicit targeting of eight words per unit, resulting in 24 words overall per grade. Each of the eight words selected per unit met these criteria: (1) it was relevant to the overall unit focus, (2) it was Tier 2 based on Beck and colleagues' selection criteria (see Beck et al., 2002), and (3) it had at least three or more lexical neighbors (i.e., words that can be formed from the target word, such as differently, differentiate, and differ for *different*). To illustrate the types of words targeted in the intervention, the eight words selected for Unit 1 for pre-kindergarteners comprised *different, shelter, habitat, alike, protect, survive, insect,* and *prairie.* Also see Table 3, which provides a list of all the words targeted over the 21-week intervention period across the five grades.

The second feature concerns the use of CBMs, which are used by teachers to provide ongoing, formative analysis of children's learning of words targeted within each unit as well as other unit objectives. Each unit's CBM includes an assessment for all eight words targeted within the unit and includes three separate activities within a given unit (see Table 2). In the first week of the unit, teachers conduct a whole-class screening of children's skills in a "CBM preview" to orient themselves to children's baseline performance. In a whole-class setting, teachers ask children to define and discuss each of the targeted words. In the sixth week of the unit, teachers individually administer the unit's CBM to all children. In the seventh week of the unit, teachers have two 30-minute lessons devoted to "stretch and review" in which they can work individually with students on any unattained goals, including knowledge of targeted vocabulary words (see Table 2).

The third feature is the teachers' implementation of four 30-minute vocabulary lessons within each unit that are designed explicitly to target children's learning of the targeted words, referenced previously (see Table 2). These Words to Know lessons are scripted so as to manualize the principles of robust vocabulary instruction discussed in various research reports (e.g., Coyne et al., 2010). Note, however, that teachers were not required to follow the lesson scripts previously, and many teachers reported using the scripts as guideline but did not follow them directly. As can be seen in Figure 1, the vocabulary lessons were designed to follow a static sequence of instruction adhering to a gradual release of responsibility protocol featuring five ordered components (Fisher & Frey, 2008): Set, I Do, We Do, You Do, and Close. The Set identifies the goal of the lesson (typically the lesson's objective), and serves to motivate children towards the lesson focus. The I Do has teachers model for students what it is they are to do or learn in the lesson, which is followed by the We Do, in which the teacher and children co-participate in doing or learning something. In the You Do, children practice the learned skill, often with a peer or within a small group. Finally, in the Close, the teacher summarizes again the goal of the lesson (what was learned). Within the framework of this protocol, teachers provided explicit definitions of targeted words and provided children with extensive word-work opportunities through book-sharing discussions, graphic organizers, games, and other activities.

The fourth feature are the brief reviews of the eight words targeted, via the Word Review and Practice (WRAP) activities mentioned previously. WRAP activities preceded non-vocabulary lessons twice per week for four weeks, providing eight additional encounters with targeted words throughout a six-week unit. The WRAP reviews last about 5 minutes and follow a static instructional routine, in which teachers showed children a picture illustrating each of the words and read sentences containing the target words.

The Double-Dose Condition. The Double-Dose version of *Let's Know!* differed from the Basic condition in that it included an extra support session following each Basic vocabulary lesson, as can be seen in Table 2. As a result, teachers implemented eight (vs. four) lessons targeting vocabulary, in addition to the eight WRAP activities that were implemented on the same schedule as in the Basic condition. To keep overall instructional time consistent across the Basic and Double-Dose conditions, several lesson types were omitted from the latter, namely Read to Know and Text-Mapping lessons. Read to Know lessons provide children with the opportunity to look at books purposefully, so as to promote motivation towards reading, whereas Text-Mapping lessons are designed to support children's development of text-structure knowledge. From a dosage perspective, children in the Basic condition receive about six hours of robust vocabulary instruction via the Words to Know lessons over the 21-week intervention period (2 hours per unit), whereas those in the Double-Dose condition receive about 12 hours of instruction (4 hours per unit).

Teacher Supports. To support teachers' implementation of *Let's Know!*,, several strategies were used. First, researchers met individually with each participating teacher prior to the start of the year to review the manual of lesson plans and to discuss each of the lesson types, including Words to Know. The manual contained all lessons and their implementation schedules, materials for each lesson, an overview of teaching strategies specific to each lesson type, and any other necessary study materials. Second, teachers independently completed a series of on-line modules prior to implementation that provided a more in-depth examination of each of the lesson types. One module was devoted entirely to elaboration of the Words to Know lessons, and it included videos of teachers implementing exemplary lessons and a moderator describing characteristics of effective lesson implementations. Completion of modules was monitored using

on-line data analytics as well as surveys completed following each module, to ensure that all modules were completed by all teachers. Third, fidelity of implementation was captured for each teacher using a lesson tracking log submitted by teachers in the two *Let's Know!* conditions. Using an online survey tool, teachers submitted a log after each lesson that documented overall completion of the lesson as well as implementation of specific lesson components. Complete lesson logs were obtained from 36 of the 38 teachers in the two instructional conditions. These logs indicated that teachers followed the scope and sequence of *Let's Know!* with relatively high fidelity. In the Basic condition, teachers implemented, on average, 54 of 63 lessons (86%; range 30 to 63), and in the Double-Dose condition, teachers implemented an average of 58 of 63 lessons (92%; range 42 to 63).

Vocabulary Measures

Children in all three conditions were administered a pretest battery of measures, a CBM during each of the three units of the intervention, and a posttest battery, each of which included a vocabulary component. For our purposes, we discuss only the vocabulary components of the battery, namely a 12-item pretest and posttest and three 4-item CBMs.

Pretest and posttest vocabulary. The pretest and posttest vocabulary measure, consisting of 12 items, was developed to examine children's knowledge of words targeted within *Let's Know!* for each grade. Four of the eight words taught per unit were selected for inclusion in the pretest/posttest, for a total of 12 words. The four words per unit were purposefully selected based on their frequency of use in the units and their importance for understanding the unit material: two words were related to the text structure featured within the unit (i.e., *setting, predict* for a unit focused on description) and two were words that children would need to learn to understand the unit's overall focus (i.e., *habitat, conserve* for a unit focused on animal habitats). Note that

each grade received a grade-specific version of *Let's Know!*, therefore, the pretest/posttest vocabulary assessment was unique for each grade.

Children were assessed for each of the 12 words at pretest and posttest by trained members of the research team at each site over the course of 3 to 4 weeks prior to and following the 21-week implementation period. Items were administered by saying, "Tell me what [target word] means." Children's responses to each item were scored live using rubrics developed for this purpose based on the protocol used by Justice and colleagues (2005): children received 2 points for a correct definition (i.e., providing a definition from the lessons or a similar one), 1 point for partially correct responses (i.e., providing a synonym, example, or partial definition), and 0 points for providing an incorrect definition, no response, or responding with "I don't know". Prior to working in the field, assessors were trained to a reliable criterion on use of the rubric. Given the score range per each of the 12 items (0-2 points), pretest and posttest scores could range from 0 to 24.

The 12 items on the pretest and posttest measure were divided into three four-item *anchor item sets*, one of which was included in the three CBMs per grade. Anchor item sets are groups of words that appear on two tests and enable linking of test scores. Since one anchor set was included in each CBM, the pretest, posttest, and the CBM test scores could be placed on a common scale so as to model children's vocabulary skills over the 21-week intervention period.

Curriculum-based measures. The CBMs were developed to assess children's knowledge of words targeted within each unit and were administered in Week 6 of each unit. In total, 15 CBMs were developed, corresponding to three per each of five grades. Each CBM included eight vocabulary items, four items selected from among the eight words targeted within a given unit, and four *linking items* reflecting one of the three four-item anchor item sets. Teachers

administered the CBMs to students in approximately 10-minute one-on-one sessions in a pen-and-paper format using the same procedures and rubrics used for the pre- and post-test administration. A sample CBM with scoring rubric appears in the Appendix.

Measurement Approach

With five pretests/posttests and 15 CBMs, the data were initially examined using item analyses and factor analyses to determine whether the measurement model reflected a single underlying construct of vocabulary knowledge. Categorical confirmatory factor analysis (CCFA; Bollen, 1998) and, when necessary, exploratory factor analysis (EFA), were used to model the factor structure of the vocabulary measures using *Mplus* version 7. Estimates were computed using a robust maximum likelihood estimator (MLR). As expected, the pretest measures in all five grades performed rather poorly, since items had not yet been taught and were very difficult. To achieve unidimensionality and Cronbach's alphas of at least .7 on the pretest measures, it was necessary to remove at least one item. The CBMs in each grade, in contrast, performed very well, with factor analyses supporting one-factor structures and Cronbach's alphas typically over .8. Posttest measures for kindergarten and grade 2 were supported by factor analyses and classical reliability; for pre-k, grade 1, and grade 3, it was necessary to remove one or more poorly-functioning items to achieve a well-fitting single factor.

Linking design. To create linkages among the pretest, posttest, and three unit CBMs per grade, the linear equating method (Kolen & Brennan, 2004) for linking was used to rescale CBMs to their corresponding pretest score scale. First, for the three anchor item sets contained with the pretest, a check was conducted to determine whether these anchor item sets were of equal difficulty. Across grades, the three anchor item sets performed quite differently at pretest and later when the same items appeared in the CBMs. Most commonly, the anchor item set

corresponding to Unit 3 was the most difficult, resulting in low scores compared to other anchor item sets. This unequal performance of anchor item sets presented a problem in that when used to link the CBMs to the pretest, the different difficulties of the anchors could confound differences due to change over time. Therefore, we first performed a linking on the three pretest anchor item sets to remove differences due to difficulty across the anchor item sets. The sum of the calibrated pretest anchor item sets is referred to as the *reference scale*. Subsequent linkings were conducted to link each CBM to the corresponding reference-scaled items.

Second, so as to include the posttest scores in analyses and for comparison, they also were rescaled to be on the reference scale. Since the posttest was the same measure as that administered at pretest, the same linking functions were used to link the pretest anchor item sets. That is, scores from the two calibrated anchor item sets and the original third anchor item set were summed for a calibrated post-test score.

Linking methods require common information, either common examinees or common items; in the present case, there are anchor items common to both the pretest and each unit's CBM. A non-equivalent groups with an anchor test (NEAT) linking design was therefore used, in which the two groups are the same children at two time points. Since this reflects before and after learning, the groups are not equivalent. The choice of linking method depends on the relationship between two test forms, such as having identical forms (as the pre- and posttest were) or similar forms with some of the same items (as was the case in the current study). Scatterplots of each unit test against the reference test indicate weak linear relationships (not pictured), so the linking of the unit tests to the reference scale utilized a linear linking method, Linear Tucker. All linkings were performed using the "equate" package in R (Albano, 2010). Note that in interpreting results, the linked scores represent the change in ability (i.e., amount of

learning of the targeted vocabulary words) for children that occurred between pretest and the three unit CBMs.

Missing data. There was some missing data on all measures used in this study. While there are no established cut offs for an acceptable amount of missing data, ranges have been suggested between 5% (Schaffer, 1999) and 10% (Bennet, 2001), with the assumption that more than 10% of data missing is likely to result in biased results. Since complete data is required across the pretest and another form for linking, a rule was devised to indicate how much missing data was allowable for the linking analysis used in this study. Specifically, if a child was missing 10% or fewer items, the child was retained and the missing scores were rescored as incorrect (0). However, if a child was missing more than 10% of the items on a form, her data were excluded. As pretest measures contained 12 items and the CBMs each contained eight items, one missing item was allowed for the pretest, but no missing data were permitted for the CBMs. At pretest, of 293 children sampled, 15 were excluded based on missing data, leaving a total of 278 children. On the three unit CBMs, 28, 32, and 48 children were missing data, for final sample sizes of $n = 258$ (CBM 1), $n = 256$ (CBM 2), and $n = 237$ (CBM 3). Sample sizes by grade and unit are detailed in Table 4.

Results

To assess the effect of *Let's Know!* on children's vocabulary skills over time, as measured by the linked vocabulary scores, a series of two-level multilevel models (MLM) were implemented as mixed linear models using SAS PROC MIXED (Singer, 1998). This approach took into account the nested data structure whereby children (level 1) were nested within teachers/classrooms (level 2). Note that although there were repeated measures of vocabulary knowledge, a longitudinal analysis was not implemented. Rather, differences between study

conditions were tested at each measurement occasion: CBM 1, CBM 2, CBM 3, and posttest. Each model also included the pretest measure as a covariate to account for any potential differences at onset of the study at pretest. All grades were tested simultaneously with a main effect of grade included as a covariate and a grade by condition interaction to control for natural differences (i.e., increases) in vocabulary skill levels as children age and progress through school. As follow-up tests, each grade was also evaluated separately to explore any grade-specific differences.

Analysis of children's outcomes over the three study conditions were modeled as a set of two Helmert contrast variables (H1: -2 = control, 1 = Basic, -1 = Double-Dose; H2: 0 = Control, -1 = Basic, 1 = Double-Dose) at the teacher/classroom level. The first Helmert contrast (H1) compares control teachers with all *Let's Know!* teacher (Basic *and* Double-Dose). The second Helmert contrast (H2) compares *Let's Know!* teachers in the Basic and Double-Dose conditions. The Kenward-Rogers method (Kenward & Rogers, 1997) was used to determine the denominator degrees of freedom for all tests of fixed effects, and all tests of fixed effects were 2-tailed hypothesis tests. Final parameter estimates for both fixed and random effects were obtained through maximum likelihood (ML) estimation. The use of MLM allows for modeling of individual differences at multiple levels of a hierarchical data structure (i.e., random effects). The random effects portion of all models featured a random intercept variance at the teacher level, which is interpreted as the variability in the within-teacher average vocabulary knowledge of the students within a particular class. The within-subjects error covariance matrix was modeled with an independence structure, resulting in a single residual error variance. The within-subjects error is the average deviation of students within a classroom from the classroom average.

Table 5 summarizes the fixed effects of the intervention evaluation for all unit

assessments by grade and overall based on all grades simultaneously by measurement occasion, and Table 6 summarizes the fixed effects of the intervention evaluation for the posttest assessment by grade and overall based on all grades simultaneously. Measures of effect size, Cohen's *d*, are included in Tables 5 and 6 for all Helmert contrast effects.

All Grades

Figure 2 depicts the significant overall (all grades combined) effect of *Let's Know!* on children's vocabulary skills over time, for both Basic and Double-Dose, relative to controls. The skill at all measurement occasions, after controlling for grade in school and pretest vocabulary skill (d_{unit1} = 1.40, d_{unit2} = 1.72, d_{unit3} = 1.40, d_{post} = 1.12). This is represented in the "H1" effects in the last panel of Tables 5 and 6. The study condition by grade interactions (H1 x Grade and H2 x Grade) were non-significant and dropped from all analyses. Although Figure 2 suggests that children in the Double-Dose version of *Let's Know!* had better vocabulary skills than those in the Basic version at Unit 1, 2, 3, and posttest, there were no statistically significant at any time point (d_{unit1} = 0.27, d_{unit2} = 0.44, d_{unit3} = 0.33, d_{post} = 0.62); this is represented as the "H2" effects in Tables 5 and 6.

By Grades

Tables 5 and 6 summarize the fixed effects of the three study conditions by grade and by measurement occasion. We provide a brief overview of the findings for each grade.

Pre-k. Children receiving *Let's Know!*, both Basic and Double-Dose, demonstrated statistically significant differences in vocabulary skills relative to controls on each of the three unit CBMs, after controlling for pretest vocabulary knowledge (d_{unit1} = 1.34, d_{unit2} = 1.30, d_{unit3} = 1.14); however, this effect was non-significant at the posttest, although the effect-size estimate was relatively large (d_{post} = 0.70). Pre-kindergarteners in the Double-Dose condition, relative to

children in the Basic condition, showed no significant differences in vocabulary skill at any time point (d_{unit1} = 0.26, d_{unit2} = -0.15, d_{unit3} = 0.18, d_{post} = 0.78), although the effect-size contrast at posttest was relatively large to favor the Double-Dose condition.

Kindergarten. Children in the *Let's Know!* conditions, both Basic and Double-Dose, relative to controls demonstrated statistically significant differences in vocabulary skills at all measurement occasions, after controlling for pretest vocabulary knowledge (d_{unit1} = 2.23, d_{unit2} = 2.90, d_{unit3} = 2.35, d_{post} = 1.75). Children in the Double-Dose condition, relative to children in the Basic condition, also showed significant differences in vocabulary skills on Unit 2 and at posttest (d_{unit1} = 1.01, d_{unit2} = 1.35, d_{unit3} = 1.03, d_{post} = 1.20).

1st Grade. Children in the *Let's Know!* conditions, both Basic and Double-Dose, relative to controls did not demonstrate significant differences in vocabulary skills at any measurement occasion, when controlling for pretest (d_{unit1} = 0.91, d_{unit2} = 1.49, d_{unit3} = 1.32, d_{post} = 0.76). In addition, no significant differences in vocabulary skills between students in the Double-Dose condition relative to the Basic condition were observed at any time point (d_{unit1} = -1.11, d_{unit2} = -0.07, d_{unit3} = -0.17, d_{post} = 0.09).

2nd Grade. As seen for the pre-k children, second graders in the *Let's Know!* conditions, both Basic and Double-Dose, relative to controls demonstrated statistically significant differences in vocabulary knowledge on all unit tests but not at posttest (d_{unit1} = 1.61, d_{unit2} = 2.49, d_{unit3} = 2.32, d_{post} = 1.46), after controlling for pretest.. Students in the Double-Dose condition, relative to children in the Basic condition, showed no significant differences in vocabulary skills at any time point (d_{unit1} = -1.11, d_{unit2} = -0.07, d_{unit3} = -0.17, d_{post} = 0.09).

3rd Grade. Children in the *Let's Know!* conditions, both Basic and Double-Dose, relative to controls demonstrated statistically significant differences in vocabulary skills on units 1 and 2

and a marginal effect at posttest, after controlling for pretest (d_{unit1} = 1.86, d_{unit2} = 2.74, d_{post} = 1.18). There was no intervention effect on Unit 3 (d_{unit3} = 0.94). There was a significant difference between students in the Double-Dose condition, relative to children in the Basic condition, on Unit 2 (d_{unit2} = 0.99), but not at any other measurement occasion (d_{unit1} = 0.15, d_{unit3} = 0.42, d_{post} = 0.57).

Discussion

The current study sought to explore the impact of a double-dose explicit vocabulary instruction compared to single-dose instruction and a control group featuring business-as-usual language-arts instruction. The double-dose condition was designed to provide additional instructional time and increased learning opportunities as a means to enhance children's learning of targeting vocabulary words. The premise that double-dose vocabulary instruction might elevate children's learning was based on previous research endorsing this approach in math instruction (e.g., Nomi & Allensworth, 2009), although its application in reading/language arts has had more mixed results. Some findings suggest that increased dosage of instruction positively affects children's learning of targeted content (e.g., Piasta et al., 2012), whereas others show that increased dosage of instruction approximates the student outcomes seen in less intensive dosage applications (e.g., single vs. double dose; see Wanzek & Vaughn, 2008). The results of the present study are more in line with the latter work, finding that children whose teachers provided double-dose vocabulary lessons (6 hours over 21 weeks) did not exhibit significantly improved learning of targeted vocabulary words relative to those whose teachers provided single-dose vocabulary lessons (12 hours over 21 weeks). Here, we discuss this finding as well as other key results of this study.

First, study results did not consistently show that Double-Dose (versus Basic) vocabulary instruction significantly elevated children's learning relative to the single-dose (Basic) condition, with posttest vocabulary scores for those in the former condition (M = 12.4) only slightly higher than those in the former condition (M = 9.3), with similar results seen for the CBMs collected at Unit 1, 2, and 3. We cannot conclude that provision of doubled vocabulary lessons significantly elevated children's learning, although the consistent direction of effects privileging Double-Dose instruction and the relatively large effect size (d = 0.62) suggests that it does provide some benefit to children's learning of targeted vocabulary words.

Interestingly, when we consider the grade-by-grade benefits of Double-Dose instruction, we find that it seems to yield particular benefit to kindergarten children, with the effect-size contrast (d = 1.2) approximating Coyne and colleagues' (2009) result when comparing extended versus embedded instruction for kindergarten children as well (d = 1.34) on a task similar to that used in this study. In that study, the contrast between extended and embedded instruction is similar to the distinction between double- and single-dose instruction in the current study. Given that Coyne and colleagues only studied kindergarten children, we cannot know if the differential effectiveness of double-dosing, in that only kindergarteners seem to benefit as seen in our study, would have occurred in theirs as well.

It is important to consider why Double-Dose instruction did not benefit children in the other grades – especially those in first and second grade (ds = 0.14 and 0.09, respectively) - and we offer two conjectures to this point. First, it may be that the dosing differences between single- and double-dose instruction were not very distinct. That is, it may be that teachers in the single-dose condition in this study provided additional opportunities outside of Words to Know lessons for children to learn about the targeted words, given that vocabulary development was a

prominent focus of the overall *Let's Know!* intervention and teachers received considerable evidence to this point, such as the inclusion of targeted words in the CBMs. In the single-dose condition, teachers typically put the unit words on word walls, and may have referred to them outside of the four-per-unit Words to Know lessons. Hulleman and Cordray detail the importance of *treatment differentiation* in educational interventions, which references the distinctiveness between an intervention and the counterfactual (Hulleman & Cordray, 2009). In the current study, it may be that the single- and double-dose conditions were not sufficiently differentiated so as to lead to significantly elevated outcomes for students, even in the context of reasonably large effect sizes. A second possibility is that double-dose instruction is only beneficial to some students, a finding consistently reported in research on double-dose math instruction. Study results are mixed, however, as to whether double-dose instruction is more beneficial for higher- or lower-performing students, with studies yielding conflicting results (Nomi & Alllensworth, 2009; 2012). With reference to vocabulary instruction, it may be that double-dose instruction enhanced learning for subgroups of children, such as those who have limited skills and thus can benefit from enhanced instructional time. We did not explore such subgroup analyses in this study, given that we were not powered to detect moderation, but future work should explore whether double-dose instruction might be differentially effective for some groups of children.

The second finding of note is that children who experienced *Let's Know!,* when considering all grades combined, did consistently outperform those receiving business-as-usual language-arts instruction, with effects similar to those seen in intervention research on explicit/robust vocabulary instruction. Marulis and Neuman's meta-analysis (2010) of studies involving pre-kindergarteners and kindergarteners reported an average effect of 0.88 standard deviation units on children's vocabulary outcomes; explicit approaches, such as those used in

Let's Know!, yielded consistently larger effects than implicit approaches (1.11 vs. 0.62, respectively). Interestingly, the effect seen for *Let's Know!*, combining both single- and double-dose applications (d = 1.12) is nearly identical to the average effect reported by Marulis and Neuman for explicit vocabulary interventions. We can translate this finding to note that vocabulary interventions that are developed based on the principles of explicit/robust instruction, which are detailed in many papers and manuals to date (see especially Beck et al., 2002), should lead to significant, deepening knowledge of targeted words by children.

An interesting contribution of this work, which is unique from most other prior studies of explicit vocabulary instruction, is the inclusion of children across five grades. While explicit vocabulary instruction was effective for promoting children's knowledge of targeted words when collapsing all grades, a grade-by-grade analysis showed these effects to be particularly robust (ds > 1) at three grades: kindergarten, second grade, and third grade. It is surprisingly that the effects of explicit vocabulary instruction was not seen for pre-kindergartners, as impacts have been previously documented for children at this age (see Marulis & Neuman, 2010); the same is true for first graders as well (Beck & McKeown, 2007). With relatively few teachers in the *Let's Know!* conditions at each of these grades (n = 7 per grade), it is possible that poor implementation by even one or two teachers in each of these grades could attenuate overall effects of the vocabulary instruction.

The implications for these findings, considered collectively, are that explicit/robust vocabulary instruction, at either the single- or double-dose intensities studied, have positive effects on children's learning of targeted words. Consideration of effect-size estimates show that these effects are reasonably robust across all grades, ranging from .7 for pre-kindergarteners to 1.75 for kindergarteners). Double-dose instruction does yield an overall increase in effects of

vocabulary instruction, relative to single-dose (d = .62), but it appears most beneficial to younger children, namely pre-kindergarteners (d = .78) and kindergartners (d = 1.2). It is unknown, however, whether these gains are maintained over time, and whether they translate to overall improved performance on generalized assessments of vocabulary skill. As noted early in this study, the relatively large effect sizes seen in vocabulary-intervention studies (averaging. 88 across studies, Marulis & Neuman, 2010) do not necessarily correspond to a large increase of number of words children learn. With this acknowledgment, caution should therefore be used in interpreting short-term impacts on learning specific targeted words on children's overall vocabulary abilities.

There are limitations to this study that warrant note. First, the current study had relatively few numbers of teachers and students within each condition across the five grades. Although we can draw some conclusions about the effects of the intervention, from a psychometric perspective the sample size was small. That is, an important feature of this study was our effort to link children's vocabulary data at pretest, posttest, and three unit CBMs. The most effective linking procedures typically require much larger samples for maximum efficiency and accuracy. Although large sample sizes ranging from n = 300 to n = 1,000 are generally recommended for psychometric research for stability and representation of the population (e.g., Comfrey and Lee, 1992), we were motivated to be as psychometrically sound as possible when evaluating the *Let's Know!* intervention. To compensate for the small psychometric sample, we implemented methods known to compensate for data limitations. For instance, the linear equating method for linking was implemented (Kolen & Brennen, 2004), and the Kenward-Roger approximation for the degrees of freedom (Kenward & Roger, 1997) was used in the multilevel models.

A second and related limitation concerns that of power. While this study was sufficiently powered to conclude that children receiving *Let's Know!* performed better than those in the business-as-usual classrooms, the study was under-powered to detect differences between the Basic versus Double-Dose versions of *Let's Know!*, given the effect sizes detected and the use of cluster assignment to condition. Because the teacher/classroom was assigned to condition, the important sample size for evaluating program effectiveness was the number of teachers ($J = 56$), rather than the much larger number of students ($N = 259$). While the full sample of teachers ($J = 56$) was used to evaluate the efficacy of *Let's Know!* versus control, only $J = 38$ teachers were used to test the difference between the dosing variations. Importantly, despite the lack of statistically significant differences between the Double Dose and Basic conditions, observed effect sizes were themselves robust, accounting for at least a one-third standard deviation improvement both overall and for three of the five grades.

Several future research directions are suggested by the results presented here. First, it is important to determine the longer-term impacts of explicit vocabulary interventions. Does an increase in children's knowledge of a small set of targeted words result in widespread change to children's vocabulary system? Are such results maintained over time, and do they lead to improved academic achievement. Addressing such questions is important to the next generation of research on vocabulary interventions. Second, it is also necessary to determine whether increased dosage would be valuable for children with critical needs in the area of vocabulary skill. Vocabulary skills are influential to reading comprehension and overall academic achievement, yet many children have vocabulary skills that are inadequate for these activities. While there is sufficient information in the literature for professionals to develop vocabulary interventions that are explicit and robust, does increasing the dosage of these interventions help

those children who most need vocabulary enhancement? While this study shows a general benefit of double-dose instruction over single-dose instruction, and complements prior work attempting to do the same (e.g., Coyne et al., 2007), will this approach help the most vulnerable children? No study to date has attempted to address this question, although it is an important need within the vocabulary intervention literature.

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Appendix

Sample Curriculum-Based Measure: Vocabulary Items Grade 2, Animals Unit

	Correct Responses Score = **2**	**Partial Credit Responses** Score = **1**	**Incorrect Responses** Score = **0**
1.	"Tell me what life cycle means." [changes that happen from the beginning to the end of a living thing, lifetime]	"Tell me more about life cycle." [Gives synonym or example: circle of life, life span]	Child does not give an acceptable definition, synonym, or example.
2.	"Tell me what complex sentence means." [a sentence with two clauses joined together by a connecting word]	"Tell me more about complex sentence." [Gives synonym or example: two ideas joined together by and, but, so etc.]	Child does not give an acceptable definition, synonym, or example.
3.	"Tell me what finally means." [the last thing]	"Tell me more about finally." [Gives synonym or example: lastly]	Child does not give an acceptable definition, synonym, or example.
4.	"Tell me what environment means." [the conditions or things that are around you, surroundings]	"Tell me more about environment." [Gives synonym or example: habitat, neighborhood]	Child does not give an acceptable definition, synonym, or example.
5.	"Tell me what index means." [an alphabetized list of names, places, and subjects that tells you where to find them in a book, where to find things in a book]	"Tell me more about index." [Gives synonym or example: guide, list]	Child does not give an acceptable definition, synonym, or example.
6.	"Tell me what species means." [a group of related living things that can have babies together, animals that can have babies together]	"Tell me more about species." [Gives synonym or example: class, variety, breed]	Child does not give an acceptable definition, synonym, or example.
7.	"Tell me what migration means." [a group moving together from one place to another, moving from one place to another]	"Tell me more about migration." [Gives synonym or example: journey, flight, trip]	Child does not give an acceptable definition, synonym, or example.
8.	"Tell me what series means." [a number of objects or events arranged in order one after the other]	"Tell me more about series." [Gives synonym or example: succession, array, line, list, progression]	Child does not give an acceptable definition, synonym, or example.

Table 1.

Child-level Characteristics by Study Condition

Variable	**Basic**		**Double-Dose**		**Control**	
Mean Age (SD)	6.92 (1.51)		6.94 (1.54)		6.84 (1.54)	
	n	%	*n*	%	*n*	%
Gender						
Male	45	52.3	45	46.9	41	42.7
Female	36	41.9	48	50.0	49	51.0
Not reported	5	5.8	3	3.1	5	6.3
Ethnicity						
Not Hispanic or Latino	74	86.1	83	86.5	81	84.4
Hispanic or Latino	6	7.0	6	6.3	11	11.5
Not reported	6	7.0	7	7.3	4	4.2
Race						
White/Caucasian	69	80.2	76	79.2	83	86.5
African American	9	10.	7	4.2	7	7.3
Asian	3	3.5	5	7.3	5	5.2
American Indian or Alaska Native	3	3.5	2	2.1	2	2.1
Native Hawaiian or Pacific Islander	0	0.0	1	1.0	0	0.0
IEP						
No	77	89.5	77	80.2	76	79.2
Yes	4	4.7	9	9.4	14	14.6
Not reported	5	5.8	10	10.4	6	6.3
Cognitive/Sensory Difficulties						
No	80	93.0	86	89.6	89	92.7
Yes	2	2.3	3	3.1	5	5.2
Not reported	4	4.7	7	7.3	2	2.1
Maternal Education						
Less than bachelor's degree	32	37.2	26	27.1	53	55.2
Bachelor's degree or higher	47	54.7	62	64.6	40	41.7
Not reported	7	8.1	8	8.3	3	3.1

Note. Multiple races could be reported. IEP=Individualized Education Program.

Table 2.

Lesson Sequence within a Let's Know! Unit: Basic and Double-Dose Versions

Week	Lesson	Basic Version	Double-Dose Version
1	1	Hook	Hook
	2	Read To Me	Read to Me
	3	**Words to Know**	**Words to Know**
	4	CBM preview*	CBM preview
2	5 (WRAP 1)	Text Mapping	**Words to Know**
	6	**Words to Know**	**Words to Know practice**
	7	Integration	Integration
	8 (WRAP 2)	Read to Know	Integration practice
3	9	Read to Me	Read to Me
	10 (WRAP 3)	Text Mapping	Integration
	11 (WRAP 4)	Integration	**Words to Know practice**
	12	**Words to Know**	**Words to Know**
4	13	Text Mapping	Integration
	14 (WRAP 5)	Integration	Integration practice
	15	**Words to Know**	**Words to Know**
	16 (WRAP 6)	Read to Know	**Words to Know practice**
5	17	Read to Me	Read to Me
	18 (WRAP 7)	Text Mapping	Integration
	19	Integration	Integration practice
	20 (WRAP 8)	Read to Know	**Words to Know practice**
6	21	Read to Know	Integration practice
	--	CBMs	CBMs
7	22	Post-CBM Stretch and Review	Post-CBM Stretch and Review
	23	Post-CBM Stretch and Review	Post-CBM Stretch and Review
	24	Close	Close

*CBM: curriculum-based measure developed for the Let's Know curriculum supplement. Teachers sample children's skill on the CBM early in a unit in a group-administered lesson (CBM Preview); the CBMs implemented in week 6 are individually administered and are followed by two "stretch and review" lessons in which teachers can review select content. WRAP = Word Review and Practice.

Table 3.

Words Targeted Across 21-Week Vocabulary Intervention for Five Grades

	Unit 1: Animals	**Unit 2: Fiction**	**Unit 3: Earth**
Pre-K	*different* *shelter* *habitat* *alike* protect survive insect prairie	order *character* *predict* repeat *escape* *lonely* appear furious	*vocabulary* classify *pebble* *trail* press layer collect *describe*
Kindergarten	*compare* *main idea* *attach* related *predator* prey but vocabulary	*result* *setting* *filthy* clever *exhausted* disguise useless conversation	*discuss* *extinct* remains form *fossil* process reasoning *monitor*
Grade 1	similarity *habitat* *however* *mammal* *otherwise* region crevice vegetation	*compare* *admire* *similar* *relieved* declare reply solution skill	*crust* boundary *pressure* reason *consequence* liquid solid *illustration*
Grade 2[a]	*life cycle* *finally* index *environment* series species migration *complex sentence*	authority *expert* *extraordinary* *multi* disgust isolation *identify* dock	horizon *particle* *phrase* conserve nutrient *mineral* *cause & effect*
Grade 3[b]	*classify* contrast *topic* *summarize* despite variation effect *adapt*	*ceremony* *sequence* *plot* conclusion culture spiral associate *solemn*	*conserve* environment *population* erosion resource *detail* *adjective* *topic*

Note. Anchor items (those items in common with pre- and post-test are italicized.

[a] = Grade 2 Unit 3 had only 7 words. [b] = Grade 3, Unit 3 had five anchor items.

Table 4

Means (M), Standard Deviations (SD), Student-Level Sample Sizes (n), and Teacher-Level Sample Sizes (J) by Condition, Occasion, and Grade

	Control				Let's Know! Basic				Let's Know! Double-Dose			
Occasion	**M**	**SD**	***n***	***J***	**M**	**SD**	***n***	***J***	**M**	**SD**	***n***	***J***
					Pre-K							
Pretest	2.32	2.41	16	4	1.59	1.49	13	3	3.30	2.02	17	4
Unit 1	2.22	2.39	16	4	6.01	2.74	12	3	6.94	4.13	17	4
Unit 2	3.68	2.13	14	4	7.84	3.86	12	3	7.33	2.92	17	4
Unit 3	1.97	1.80	13	4	4.86	2.94	10	3	5.46	3.50	16	4
Posttest	4.52	3.72	15	4	5.75	4.03	12	3	9.33	5.05	14	4
					Kindergarten							
Pretest	2.02	1.15	20	4	5.31	3.66	15	3	6.99	2.73	20	4
Unit 1	2.01	0.67	18	4	7.67	4.60	15	3	11.58	3.16	18	4
Unit 2	4.79	3.04	19	4	11.86	3.47	14	3	15.57	2.11	20	4
Unit 3	2.63	1.06	18	4	9.27	4.32	14	3	13.68	4.28	19	4
Posttest	4.16	2.59	18	4	9.08	4.66	14	3	14.78	4.79	19	4
					1st Grade							
Pretest	4.99	2.10	10	2	5.24	3.31	22	5	5.65	3.83	20	4
Unit 1	5.64	2.58	7	2	9.26	4.40	25	5	9.17	3.69	19	4
Unit 2	3.80	2.05	9	2	10.10	4.61	24	5	10.10	4.55	20	4
Unit 3	5.58	3.11	10	2	11.63	4.94	18	4	10.83	4.19	20	4
Posttest	6.64	3.84	10	2	9.31	4.18	23	5	9.85	3.43	20	4
					2nd Grade							
Pretest	5.06	1.73	19	4	7.37	1.76	5	1	7.34	2.98	22	5
Unit 1	7.05	3.16	18	4	17.20	1.75	5	1	12.62	4.43	22	5
Unit 2	5.71	2.87	18	4	14.78	3.95	5	1	14.51	4.02	22	5
Unit 3	5.02	2.51	19	4	12.99	2.88	5	1	12.37	3.80	23	5
Posttest	7.15	3.47	19	4	12.94	5.63	5	1	13.37	4.53	23	5
					3rd Grade							
Pretest	3.81	2.31	20	4	5.54	3.00	20	4	6.10	3.62	20	5
Unit 1	4.02	2.57	19	4	9.42	3.74	20	4	9.90	2.64	18	5
Unit 2	3.02	1.94	20	4	8.35	2.49	20	4	10.61	2.07	20	5
Unit 3	4.41	1.99	14	3	6.80	3.95	18	4	8.39	3.53	18	5
Posttest	6.30	3.99	19	4	10.74	5.77	19	4	13.75	4.82	19	5
					All Grades							
Pretest	3.53	2.30	85	18	4.84	3.32	75	16	5.98	3.36	99	22
Unit 1	4.03	3.08	78	18	9.00	4.58	77	16	10.18	4.13	94	22
Unit 2	4.25	2.64	80	18	9.91	4.13	75	16	11.81	4.41	99	22
Unit 3	3.86	2.46	74	17	8.85	4.83	65	15	10.41	4.74	96	22
Posttest	5.73	3.64	81	18	9.30	5.04	73	16	12.39	4.91	95	22

Table 5. *Fixed Effect Estimates, Inference Tests, and Effect Sizes (d) by Unit and Grade*

	Unit 1						Unit 2						Unit 3					
Effect	**Est.**	**SE**	**df**	**t**	***p***	***d***	**Est.**	**SE**	**df**	**t**	***p***	***d***	**Est.**	**SE**	**df**	**t**	***p***	***d***
									Pre-K									
Int	3.85	0.82	15.0	4.67	<.01		4.78	0.73	16.7	6.58	<.01		3.19	0.76	17.4	4.17	<.01	
Pretest	0.50	0.25	36.1	1.99	0.05		0.61	0.22	35.1	2.74	0.01		0.34	0.23	30.6	1.47	0.15	
H1	1.37	0.37	7.4	3.73	0.01	1.34	1.31	0.33	8.4	4.00	<.01	1.30	1.06	0.31	7.5	3.38	0.01	1.14
H2	0.09	0.70	8.0	0.13	0.90	0.26	-0.74	0.60	7.9	-1.22	0.26	-0.15	0.02	0.58	7.2	0.03	0.98	0.18
									Kindergarten									
Int	4.30	0.85	27.5	5.05	<.01		8.29	0.78	35.3	10.57	<.01		6.73	1.10	22.0	6.13	<.01	
Pretest	0.57	0.13	43.5	4.33	<.01		0.51	0.14	48.8	3.71	<.01		0.37	0.16	43.6	2.40	0.02	
H1	1.75	0.43	11.1	4.05	<.01	2.23	2.28	0.34	14.2	6.66	<.01	2.90	2.40	0.59	10.4	4.04	<.01	2.35
H2	1.41	0.72	8.2	1.95	0.09	1.01	1.42	0.53	9.0	2.69	0.03	1.35	1.84	1.00	7.9	1.85	0.10	1.03
									1st Grade									
Int	5.34	1.40	14.9	3.82	<.01		5.83	1.48	15.9	3.94	<.01		7.20	1.64	14.4	4.38	<.01	
Pretest	0.44	0.14	40.9	3.11	<.01		0.40	0.17	44.9	2.32	0.02		0.36	0.20	40.7	1.78	0.08	
H1	1.32	0.95	8.5	1.39	0.20	0.91	1.94	0.95	7.9	2.04	0.08	1.49	1.70	1.00	6.4	1.70	0.14	1.32
H2	-0.16	1.19	7.8	-0.13	0.90	-0.02	0.06	1.22	7.8	0.05	0.97	<0.01	-0.07	1.35	6.6	-0.05	0.96	-0.17
									2nd Grade									
Int	7.15	1.47	30.7	4.87	<.01		5.91	1.41	28.8	4.19	<.01		4.48	1.21	32.0	3.69	<.01	
Pretest	0.78	0.17	44.7	4.68	<.01		0.86	0.19	40.7	4.61	<.01		0.85	0.16	42.0	5.18	<.01	
H1	2.13	0.59	11.4	3.59	<.01	1.61	2.30	0.41	7.8	5.54	<.01	2.49	1.88	0.35	7.4	5.41	<.01	2.32
H2	-2.15	1.28	8.4	-1.68	0.13	-1.11	-0.23	0.85	6.1	-0.27	0.79	-0.07	-0.34	0.71	5.9	-0.48	0.65	-0.17
									3rd Grade									
Int	4.93	0.73	32.4	6.79	<.01		6.43	0.58	44.7	11.15	<.01		3.88	1.02	18.8	3.79	<.01	
Pretest	0.57	0.11	47.9	5.22	<.01		0.18	0.09	53.9	1.90	0.06		0.53	0.12	39.4	4.48	<.01	
H1	1.52	0.34	8.3	4.51	<.01	1.86	2.04	0.24	10.8	8.69	<.01	2.74	0.89	0.61	8.1	1.46	0.18	0.94
H2	0.19	0.57	8.1	0.34	0.74	0.15	1.10	0.39	10.3	2.82	0.02	0.99	0.92	0.93	8.3	0.99	0.35	0.42
									All Grades									
Int	4.35	0.50	94.0	8.79	<.01		6.50	0.52	91.0	12.51	<.01		4.75	0.58	87.0	8.15	<.01	
Grade	0.52	0.24	57.0	2.20	0.03		-0.13	0.25	55.0	-0.53	0.60		0.18	0.28	54.0	0.64	0.53	
Pretest	0.59	0.06	236.0	9.17	<.01		0.47	0.07	237.0	7.02	<.01		0.53	0.07	213.0	7.23	<.01	
H1	1.51	0.24	63.0	6.34	<.01	1.40	1.89	0.25	54.0	7.41	<.01	1.72	1.55	0.29	52.0	5.30	<.01	1.40
H2	0.38	0.41	55.0	0.94	0.35	0.27	0.74	0.43	52.0	1.71	0.09	0.44	0.64	0.50	51.0	1.29	0.20	0.33

Table 6

Fixed Effect Estimates, Inference Tests, and Effect Sizes (d) by Grade at Posttest

Effect	Est.	SE	df	t	*p*	*d*
			Pre-K			
Int	3.92	1.34	16.3	2.92	0.01	
Grade						
Pretest	1.04	0.36	34.9	2.88	0.01	
H1	0.86	0.66	7.4	1.30	0.23	0.70
H2	0.78	1.24	8.2	0.63	0.55	0.78
			Kindergarten			
Int	4.99	1.02	34.6	4.87	<.01	
Grade						
Pretest	0.90	0.18	46.7	4.97	<.01	
H1	1.36	0.44	13.4	3.07	0.01	1.75
H2	2.04	0.68	8.2	3.01	0.02	1.20
			1st Grade			
Int	5.62	1.20	19.3	4.68	<.01	
Grade						
Pretest	0.54	0.17	45.5	3.24	<.01	
H1	0.85	0.64	6.8	1.32	0.23	0.76
H2	0.31	0.84	7.2	0.37	0.72	0.14
			2nd Grade			
Int	3.91	2.91	7.2	1.35	0.22	
Grade						
Pretest	1.08	0.21	36.8	5.09	<.01	
H1	-1.67	1.44	6.7	-1.16	0.29	1.46
H2	-2.77	3.44	4.2	-0.80	0.46	0.09
			3rd Grade			
Int	4.93	1.15	25.0	4.28	<.01	
Grade						
Pretest	1.07	0.16	45.4	6.61	<.01	
H1	1.37	0.59	7.1	2.34	0.05	1.18
H2	1.45	0.98	7.0	1.48	0.18	0.57
			All Grades			
Int	4.43	0.62	99.0	7.16	<.01	
Grade	0.21	0.28	53.0	0.73	0.47	
Pretest	0.88	0.09	240.0	10.18	<.01	
H1	0.82	0.29	55.0	2.88	0.01	1.12
H2	0.57	0.49	50.0	1.18	0.24	0.62

Figure 1. Example of a Words to Know Lesson for Kindergarten

<table>
<tr><td>LET'S KNOW!
KINDERGARTEN</td><td>ANIMALS
COMPARE AND CONTRAST</td><td>WORDS TO KNOW
LESSON 3</td></tr>
<tr><td colspan="3">SHOW ME WHAT YOU KNOW! We will make a book about animals in different habitats, showing similarities and differences.</td></tr>
<tr><td colspan="3">TEACHING OBJECTIVES:
• Define words by providing a simple definition: compare, main idea, attach, related
• Use the words in spoken sentences.</td></tr>
<tr><td colspan="2">TEACHING TECHNIQUES:
• Rich Instruction
LESSON TEXT:
• Life in a Coral Reef by Wendy Pfeffer
TALK STRUCTURE FOR WE DO/YOU DO:
• Think-Pair-Share</td><td>LESSON MATERIALS YOU PROVIDE:
• N/A
UNIT MATERIALS PROVIDED:
• Words to Know rings and word strips
• Vocabulary Picture Cards: compare, main idea, attach, related</td></tr>
<tr><td colspan="3">SPECIAL INSTRUCTIONS FOR THIS LESSON:
• The Words to Know Rings have word strips with a picture and definition. You should cut, punch and assemble the rings with the first four words (compare, main idea, attach, related) prior to the first lesson.</td></tr>
<tr><td colspan="3">LESSON ROUTINE</td></tr>
<tr><td>SET</td><td colspan="2">Engage students' interest; activate their background knowledge on the skill or concept you will teach by providing an example. State the purpose of the lesson and why it's important for listening or reading comprehension.

You could say:
"Our world is filled with words and the more words we know, the better we can explain what we want to say! Today, we're going to discuss four new Words to Know, compare, main idea, attach, and related. We'll talk about what they mean and how to use them. You have a ring with the words on them to help you learn the new words. By the end of the lesson, you'll be able to say what these words mean and know how to use them. Ready?"</td></tr>
<tr><td>I DO/
WE DO</td><td colspan="2">Teach main concept or skill using clear explanations and/or steps. Model two examples for the skill or concept students will practice in YOU DO. Show a completed sample if appropriate. Provide guided practice, feedback, and support, ensuring active participation of all students. Check for understanding, ensuring that students are ready for independent practice before moving to YOU DO.

You could say:

"The first word we want to know is compare. Say the word compare. Compare means 'say how</td></tr>
</table>

things are the same or different.'

- Here is a picture that shows the meaning of **compare.** Find **compare** on your word ring. Let's say the definition together, 'say how things are the same or different.' We can **compare** the balls to see how the balls are the same and different. We can look at the shape, size, sport, or touch.
- In our slide show about animals, we **compared** one animal with another. Some things were the same and some things were different. When you go shopping for school shoes, you **compare** two or three different shoes and decide which ones you like best, and then your mom probably **compares** the prices to see which one she can buy. At your birthday party, you **compare** the packages to see which one is the biggest, right?
- Look at your word ring. What does **compare** mean? 'Say how things are the same or different.'
- What's the word? **Compare.**

"Our next word is **main idea.** Say **main idea.** The main idea is 'what the story or message is about.'

- Here is a picture that shows the meaning of **main idea.** Find **main idea** on your word ring. Let's say the definition together, 'what the story or message is about.' The **main idea** of this newspaper is that kids love kindergarten.
- In the story of Snow White, the **main idea** is that the evil queen was trying to kill Snow White but she survived. That's the message of the story or **main idea**. In our book, Desert Animals, the **main idea** is about animals that live in the desert. The **main idea** of The Avengers is that superheroes save the world.
- Look at your word ring. What does **main idea** mean? 'what the story or message is about.'
- What's the word? **Main idea.**

"The next word is **attach.** Say **attach. Attach** means 'to connect or join.'

- Here is a picture that shows the meaning of **attach.** Find **attach** on your word ring. Let's say the definition together, 'to connect or join.' The paper clip is **attached** to the note. It's connected to it.
- I can **attach** a picture to the board with tape or a stick pin. I can **attach** papers or connect papers with a stapler or a paper clip. My button is **attached** to my shirt.
- Look at your word ring. What does **attach** mean? 'To connect or join.'
- What's the word? **Attach.**

"The last word is **related.** Say **related. Related** means 'connected or belonging together.'

- Here is a picture that shows **related.** Find **related** on your word ring. Let's say the definition together, 'connected or belonging together.' The piglets are **related** to the

	mama pig. • Different kinds of dogs are **related.** They look different, but they're all dogs so they're **related**. People who are **related** to you are part of your family. You belong together. Snakes and lizards are **related**. They're both reptiles. • Look at your word ring. What does **related** mean? 'Connected or belonging together.' • What's the word that means 'connected or belonging together?' **Related.**
YOU DO	**Provide at least two opportunities for each student to complete independent practice of the skill or application of the concept. Provide individualized feedback. At the end of YOU DO bring students back together and focus their attention on you before beginning the CLOSE.** **You could say:** "Now we're going to play a game with our words. I'll say part of a sentence. Think of a word that fits, find it on your word ring and then raise your hand. I'll ask one of you for the answer. Ready? • When I'm reading a story about an animal, I want to know *what it's about* or the… • To put something *together* is to … • Your *cousin* is …. • Would you **attach** or **compare** two video games? • My belt loop is … to my jeans. • When stand next to your sister and look at how tall she is you… • *Snakes* and *lizards* are … • Scotch *tape* helps you ….. • When you *say how things are the same and different*, you ….. • What does **attach** mean? What is the **main idea**? What does **related** mean? How about **compare**? "Now turn to your partner; one of you use a sentence with **related** and the other use **compare** in a sentence … Now one partner use **main idea** and the other use **attach**."
CLOSE	**Help students briefly review the key skills or concepts they learned, suggest how they could apply them in other activities or contexts, and bring the lesson to an orderly close.** **You could say:** *"*We need to get really good at learning new words because words help us understand and explain things. Today we learned four new Words to Know. Tell your partners the word that means 'say how things are the same or different' (**compare)**; 'what the story or message is about' **(main idea)**; **'**to connect or join'**(attach);** 'connected or belonging together' **(related).** Try to use one or more of these words today when you're talking."

Figure 2. Plot of observed means per measurement occasion collapsed across grades.