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Improving Reading Comprehension in the Primary Grades:

Mediated Effects of a Language-Focused Classroom Intervention

Language and Reading Research Consortium (LARRC)

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Abstract

Purpose: This paper includes results from a multi-state randomized controlled trial designed to investigate the impacts of a language-focused classroom intervention on primary grade students' proximal language skills and distal reading comprehension skills.

Method: The sample included 938 children from 160 classrooms in four geographic regions in the United States; each classroom was randomly assigned to one of two experimental conditions (two variations of a language-focused intervention) or business-as-usual (BAU) control. For this study, the two experimental conditions were collapsed as they represented minor differences in the language-focused intervention. All children completed assessments at multiple time points during the academic year. Proximal measures (curriculum-aligned measures of vocabulary, comprehension monitoring, and understanding narrative and expository text) were administered throughout the school year. Distal measures of reading comprehension were administered at the beginning and the end of the school year.

Results: Multilevel multivariate regression was conducted with results showing that students receiving the language-focused intervention significantly outperformed those in the control group in comprehension monitoring and vocabulary, with effect sizes ranging from .55-1.98. A small effect in understanding text (narrative) was found in third grade only. Multilevel path analyses were then conducted to examine if the intervention had a positive impact on reading comprehension through the influence of proximal language outcomes. In all three grades, instruction impacted reading comprehension via the mediation of vocabulary, with sizable effects (1.89-2.26); no other indirect pathways were significant.

Conclusions:
This study provides evidence that a language-focused intervention can positively impact students' performance on language measures that are closely aligned with the intervention, with indirect, large effects on distal reading comprehension measures. Theoretically, this study provides causally interpretable support for the language bases of reading comprehension.

Improving Reading Comprehension in the Primary Grades: Mediated Effects of a Language-Focused Classroom Intervention

Poor reading comprehension among U.S. children and youth is an ongoing concern; indeed, nationally representative data show stagnant performance in reading achievement over the past decades (Snyder, de Brey, & Dillow, 2016), with only about one-third of fourth graders exhibiting proficient reading skill (National Assessment of Educational Progress, 2017). Poor reading achievement is associated with adversities in a number of areas, including educational progress, employment opportunities, and health outcomes (Ritchie & Bates, 2013). In recent decades, considerable efforts have been directed towards developing effective interventions for improving children's decoding skills, many with successful outcomes (Ball & Blachman, 1988; Connor, Morrison, Fishman, Schatschneider, & Underwood, 2007). In contrast, there has been less attention to improving children's reading comprehension, although it is a decidedly important component of skilled reading. To address this issue, the Institute of Education Sciences (IES) of the U.S. Department of Education created the Reading for Understanding (RFU) Initiative in 2010. The purpose of this initiative was to commit extensive funding (more than $100,000,000) to investigative teams to develop, refine, and evaluate effective approaches for improving reading comprehension for children and youth.

The present manuscript describes the results of a multi-state experimental evaluation of a whole-class comprehension-focused intervention developed by the Language and Reading Research Consortium (LARRC), a group of investigators from multiple sites and disciplines who received funding to investigate reading comprehension development and instruction in preschool through third grade. The primary aim of the

LARRC team was to determine the effects of *language-focused* whole-class interventions, representing an enhancement of or supplement to the typical classroom language-arts curriculum – for improving reading comprehension in the primary grades.

LARRC's focus on language-focused intervention as a means for improving overall reading comprehension is based on firm theoretical evidence showing that children's language comprehension is intricately related to reading comprehension skills (e.g., Kintsch & Kintsch, 2005; Perfetti, 1999; Scarborough, 1998). By third grade, children's language skills explain an estimated 60% of the variance in children's reading comprehension (Language and Reading Research Consortium, 2015), and the contribution of language skill to reading contribution is important across the continuum of reading skill (Language and Reading Research Consortium & Logan, 2017). In fact, among the least-skilled comprehenders in third grade (bottom tertile), skills in grammar, vocabulary, and higher-level language appear more influential to reading comprehension than for the most-skilled comprehenders (Language and Reading Research Consortium & Logan, 2017). This suggests that language skill may be an important lever of change for improving reading comprehension across the full distribution of reading skill.

Among the most critical determinants of language comprehension are language skills transcending both lower- (i.e., automatic) and higher-level (i.e., integrative) processes (Perfetti, 2007). Lower-level language skills, such as vocabulary and grammar, are significant contributors to reading comprehension (Verhoeven & Van Leeuwe, 2008). These skills are viewed as *necessary but not sufficient* for reading comprehension, and in essence, are thought to lay the foundation for higher-level language skills. Higher-level skills include making inferences, using text structure knowledge, and

comprehension monitoring, and these skills are viewed as critical for the integrative elements of skilled reading comprehension that allow one to create a mental model of text (Cain, Oakhill, Barnes, & Bryant, 2001).

Given the contribution of language skills to skilled reading comprehension, some have proposed that instruction directly targeting language skills has the potential to result in improvements in reading comprehension (Bowyer-Crane et al., 2008; Williams, Hall, & Lauer, 2004). This argument was first tested in a seminal study conducted by Beck and colleagues (Beck, Perfetti, & McKeown, 1982), in which fourth grade students were provided with explicit vocabulary instruction using a variety of tasks, such as word definition activities. Results indicated that the vocabulary instruction had a positive, significant effect on not only vocabulary skills but also students' reading comprehension. These studies, as well as others (Cirino, Pollard-Durodola, Foorman, Carlson, & Francis, 2007; Zipke, Ehri, & Cairns, 2009), provide preliminary evidence that providing direct instruction in language skills can positively impact children's reading comprehension.

Typically, efforts to positively impact reading comprehension via language instruction focus on one specific language skill, such as vocabulary or inference making. For instance, Beck and colleagues' (Beck et al., 1982) previously cited work showed that instruction targeting vocabulary knowledge can lead to improvements in reading comprehension. However, as previously noted, the extant research provides evidence that reading comprehension is associated with a variety of different language skills, including not only vocabulary but also one's grammar abilities, inferencing skills, text-structure knowledge, and comprehension monitoring (Cain et al., 2001; Cain, Oakhill, & Bryant, 2004). In fact, recent evidence finds that these language skills are influential to reading

comprehension across the continuum of reading skill (Language and Reading Research Consortium & Logan, 2017).

To date, relatively few multi-component language interventions have been examined for effects on reading comprehension, with a few exceptions (Clarke, Snowling, Truelove, & Hulme, 2010; Williams et al., 2014; Williams, Stafford, Lauer, Hall, & Pollini, 2009). One example is seen in work by Williams and colleagues , who developed and tested a supplemental classroom intervention for second-grade students that provided explicit instruction targeting a variety of language skills, including vocabulary, grammar and text-structure knowledge (Williams et al., 2009). Vocabulary instruction focused on concepts central to the topic of texts being read (e.g., warm- and cold-blooded animals) but also on "clue words" that helped children to comprehend certain expository texts. For instance, when reading compare-contrast texts, children received instruction on such clue words as *both, compare,* and *alike.* Also, children engaged in extensive textual analysis of expository text, including grammatical analyses (e.g., examining coherence within paragraphs) and text-structure analysis (e.g., producing graphic organizers depicting a paragraph's expository structure). Compared to children in two counterfactual conditions, children provided explicit instruction focused on vocabulary, grammar, and text-structure skills showed better reading comprehension on distal (transfer) experimental-developed tasks as well as improvements in targeted vocabulary skills and background knowledge (see Williams et al., 2009). The results of a study by Clarke and colleagues (Clarke, Snowling, Truelove, & Hulme, 2010) also demonstrated promising results of language-focused instruction with 8-to 9-year-old students. In this randomized controlled trial, students who received instruction targeting

vocabulary, narrative ability, and listening comprehension outperformed students in a control condition on a standardized measure of reading comprehension, and these gains were maintained at an 11-month follow-up. It is important to note that the instruction provided in this study was delivered individually, not in a classroom setting.

Similar to the intervention developed and tested by Clarke and colleagues (2010), the present experiment examined effects of a comprehensive language-focused intervention – *Let's Know!* - on the language skills and reading comprehension of first- to third-grade students; a principal distinction between the present work and Clarke et al was that the intervention described here was implemented by classroom teachers and delivered to the entire classroom. Designed as a supplement to the classroom's typical language-arts curriculum, *Let's Know!* was developed and tested over a three-year period in a process that adhered to the Curriculum Research Framework (CRF) approach developed by Clements and colleagues (Clements, 2007). The CRF is a systematic 10-step approach for generating and testing research-based curricular methods that transcends establishing the educational goals of the curriculum (Step 1) to evaluating the curriculum in an experimental large-scale trial (Step 10).

LARRC's approach to curricular development based on the CRF, as well as a detailed description of the intervention, is thoroughly discussed under separate cover (Language and Reading Research Consortium, 2016). In brief, *Let's Know!* was designed to provide primary-grade teachers a systematic and explicit approach to targeting children's language skills, including vocabulary, inference-making, comprehension monitoring, and text-structure knowledge, given evidence linking these skills to longitudinal outcomes in reading comprehension (Cain et al., 2001; Cain et al., 2004).

Organized into four stand-alone thematically based instructional units, teachers provided whole-class instruction for approximately 30-minutes per day using semi-scripted lesson plans design to articulate a scope and sequence of language-focused instruction (see Table 1). Each unit consisted of a sequenced set of instructional lessons focused on various language skills (e.g., vocabulary was targeted in "Words to Know" lessons and text-structure knowledge was targeted in "Text Mapping" lessons).

Let's Know! was designed to augment but not supplant the core language-arts program used by teachers, as initial input from educators indicated that an intervention would be of more value to school districts if it could be embedded into existing language arts programs (see LARRC, 2016). Thus, design of the intervention included attention to examining the extent to which primary-grade teachers could use the intervention with fidelity in conjunction with a variety of language-arts curricula (e.g., Language and Reading Research Consortium, Pratt, & Logan, 2014).

Two variations of *Let's Know!* were developed, one targeting a broader array of language skills than the other, with the latter focusing more intensively on vocabulary with repetition of vocabulary-focused lessons. The distinguishing features of the two versions are reported elsewhere and referenced in Table 1 (see Language and Reading Research Consortium, 2016). Generally, studies do not find the two instantiations to be significantly different in their impact on students' language skills (e.g., Language and Reading Research Consortium, Arthur, & Davis, 2016); thus, in the present study we do not differentiate between *Let's Know!* versions, although classrooms were randomly assigned to implement either of the two variations.

To date, several reports on the impacts of *Let's Know!* have presented positive

effects of the intervention on students' language skills, including vocabulary and text-structure knowledge (Language and Reading Research Consortium et al., 2016; Language and Reading Research Consortium, Jiang, & Davis, 2017a). Preliminary results from the two-cohort randomized controlled trial reported here included examiniation of treatment effects among the first cohort of students whose teachers implemented *Let's Know!*. That study showed statistically significant effects on measures of comprehension monitoring and vocabulary relative to control (Language and Reading Research Consortium et al., 2017). These results provide promising preliminary evidence that explicit, targeted instruction can positively impact those language skills shown to be important for later reading comprehension. Distinct from these prior works, the present study represents the complete evaluation of impacts of the language-focused intervention on students' reading comprehension in the primary grades, with a specific focus on testing the theory of change inherent to the intervention's design – namely, that *Let's Know!* yields positive effects on language skills which, in turn, positively affect reading comprehension.

The present study addressed two aims within the context of a large-scale, multi-state randomized controlled trial (RCT) involving two successive cohorts of first- to third-grade students and their teachers. (Note that the RCT also included preschool and kindergarten students; those results are analyzed separately, as measures of reading comprehension were not collected on these youngest participants.) The first purpose was to examine the impacts of *Let's Know!* on the language skills of first- through third-grade students over an academic year, specifically comprehension monitoring, vocabulary, and text comprehension (narrative and expository). We theorized that students whose teachers implemented *Let's Know!* for an academic year would outperform children in control

classrooms on these outcomes, thus generally serving to replicate preliminary findings recently reported in the literature (Language and Reading Research Consortium, Jiang, & Davis, 2017b). The second purpose was to determine the extent to which the effects of the intervention on children's language skills would transfer to effects on reading-comprehension skills, as reflected in the theory of change that guided design of the *Let's Know!* intervention. Specifically, this theory of change contends that children's reading comprehension is highly influenced by their language skills (Language and Research Research Consortium & Logan, 2017), and that instruction targeting such skills should causally affect reading comprehension. This theory therefore proposes that the effects of *Let's Know!* on students' reading comprehension is mediated by their language skills. Thus, the questions addressed in this study were twofold: (1) To what extent does Let's Know! impact the language skills of primary-grade children, including comprehension monitoring, vocabulary, and language comprehension, and (2) To what extent does Let's Know! impact the reading comprehension skills of primary-grade children via the influence of language skills?

Methods

Participants

Preschool to third-grade students enrolled in public schools across six states were enrolled in two sequential cohorts (2013-14, 2014-15 academic years) to conduct an RCT of the *Let's Know!* classroom-based intervention. Each cohorts contain an unique sample of students. Because the outcome measures in the RCT differed for the preschool to kindergarten students and the first-to-third grade students, this paper is limited to the latter group of students ($N = 997$) to assess the potential effects of the intervention on

students' language and reading-comprehension outcomes. As most preschool and kindergarten students cannot read text, curricular effects for these youngsters were assessed using language-specific measures, and results are examined under separate cover. Note that the sample utilized in this study partially overlaps with that described in LARRC, Jiang, and Davis (2017), which examined the effects of the *Let's Know!* intervention on curriculum-aligned language measures using the preschool to third grade sample from cohort 1 of the RCT.

Teacher sample. To recruit teachers into the study, school districts across six states were pursued as possible participants based on school/district size, diversity of students served, and geographic proximity and prior engagement in research partnerships with university sites with which the investigators were affiliated. While the districts generally reflected a convenience sample, careful attention was paid towards identifying districts that helped to balance differences across the states with respect to student demographics, especially race/ethnicity and rurality. Once permission was provided by district leaders, project staff held information sessions in each district to provide teachers with information about the study goals and activities. Subsequently, teachers self-selected into the study and provided informed consent. Those enrolled into the study agreed to implement one of two variations of *Let's Know!* into their core language-arts curriculum or to maintain their business-as-usual curriculum; the two variations represented modest distinctions in the scope of language-focused instruction taking place, as referenced previously (for complete description of the versions, see Ahn & Vassileva, 2016; Language and Reading Research Consortium, 2016). Only minimal details as to what implementation of *Let's Know!* would entail were provided at the consent stage, although

we emphasized that teachers assigned to one of two experimental conditions would need to be prepared to make adjustments to their language-arts curriculum.

The sample of 184 first- to third-grade teachers was primarily white/Caucasian (91%), although 6% were Asian, and 3% were of other races or multiracial. Four percent of teachers identified as Hispanic or Latino. On average, teachers were 42 years old (*SD* = 10.5 years, range = 23 to 65 years) and had nearly eight years of experience teaching the current grade level (*SD* = 6.2 years, range = 0 to 32 years). An average classroom included 22 children (*SD* = 3.4, range = 8 to 30). Almost two-thirds of classrooms were in suburban settings (62%), with 25% in urban settings, and 13% in rural settings. According to teacher report, nearly all (95%) classrooms were using a specific language-arts curriculum, to which *Let's Know!* served as a supplement.

Student sample. All children whose teachers enrolled in the study were exposed to their teachers' assigned study conditions. Consent therefore was requested of children's caregivers to allow their children to participate in ongoing assessments to assess effects of instructional conditions on language and reading skills. To ascertain the children for ongoing assessments, study information was provided to all children in each classroom via "backpack mail;" this included an informational brochure, an informed consent form, and a brief screening questionnaire that captured information used to identify children eligible for ongoing assessments. Children were eligible to participate if (a) they were proficient in English, per caregiver report, (b) had no profound sensory or cognitive difficulties or disabilities that would prevent participation in assessments, and (c) would be present in the classroom during the *Let's Know!* lessons.

Out of all eligible children for whom consent was received, six were randomly selected from each classroom to be assessed throughout the year. In cases in which fewer than six children were eligible in a classroom, all were selected. The decision to select six children per classroom was based on *a priori* power analyses which were conducted to ensure adequate statistical power for detecting differences among the study conditions for student-level outcomes. These estimates assured us that the study was designed with sufficient power to detect educationally-meaningful effects.

In total, 997 first- to third-grade students were enrolled in the study, representing 184 first- to third-grade classrooms and an average of slightly more than 5 children per classroom. After removing cases that had missing data on all outcome variables, we retained an analytic sample of 938 children from 160 classrooms. Detailed missing data analyses are reported in the Results section (see "Attrition and Initial Equivalence"). Selected descriptive information of the final sample ($N = 938$) is summarized by grade in Table 2. Across all grade levels, 51~53% of the students were female and 29~43% were identified as ethnic minorities. The average age at the start of the academic year was 6:10 for grade 1, 7:11 for grade 2, and 8:11 for grade 3 (range = 65 to 131 months). Per caregiver report, 6~11% of children had an Individualized Education Plan and the majority of families (>90%) spoke English as the primary language at home. To characterize the students' socioeconomic status (SES), information about maternal education was captured; 41% of children's mothers had high school degree as their highest level of education earned, 31% had associates or bachelor's degree, and 17% had advanced degree. Thus, this sample was diverse with respect to SES.

Procedures

Prior to the start of the school year, and after teachers provided informed consent, each classroom was randomly assigned to one of three condition, representing the two version of *Let's Know!* or a business-as-usual (BAU) control. Random assignment was blocked by site and grade to ensure uniformity in assignment procedures.

In classrooms assigned to one of the two *Let's Know!* conditions, teachers implemented the whole-class intervention over a 25-week period, whereas those in the BAU condition were asked to maintain their typical language-arts curriculum. Regardless of study condition, all participating teachers completed the same number of hours of professional development (˜6 hours total) prior to the fall semester, with those in the BAU condition receiving training on neutral topics (e.g., classroom management); received similar incentives; and went through similar data collection procedures. Therefore, implementation of *Let's Know!* was the only distinguishing characteristic for experimental versus control classrooms.

Let's Know! intervention. *Let's Know!* is a language-focused curricular supplement designed to systematically and explicitly improve children's lower- and higher-level language skills. Targeted skills include grammar, vocabulary, text-structure knowledge, inferencing, and comprehension monitoring. These skills were selected for emphasis in the supplement given their established longitudinal relations to reading comprehension (Cain et al., 2001; Language and Reading Research Consortium & Logan, 2017). A scope and sequence of instruction was derived from the extant literature to identify specific skills per each of five grades (preschool to third grade) that should be explicitly targeted in structured lessons each week. In turn, this scope and sequence was used to generate a comprehensive set of units and corresponding lessons to target

students' skills in these areas over an academic year.

The whole-class intervention for each grade consisted of four units, two emphasizing narrative texts and two emphasizing expository texts, with an overarching focus across all four units on science-related topics. The first three units consisted of a series of 24 structured, ordered lessons, whereas unit four had 13 lessons (see Table 1), each of which follows a specific instructional routine. Lessons were organized into three 7-week units plus one 4-week unit (Unit 1: Fiction, Unit 2: Animals, Unit 3: Earth Materials, Unit 4: Folktales), for a total of 25 weeks. Each lesson targets one or more of the key language skills within the scope and sequence of instruction. All lessons were semi-scripted, were designed to last about 20- to- 30-minutes, and followed a gradual release of responsibility model. Specifically, each lesson opened with a 'Set' in which the teacher explicitly stated the goal of the lesson; this was followed by three successive segments of 'I Do' (teacher models a skill or objective), 'We Do' (students practice with teacher scaffolding), and 'You Do' (students practice independently). Each lesson ended with a 'Close,' in which the teacher restated the goal of the lesson. The entire curricular supplement can be downloaded at no cost at https://larrc.ehe.osu.edu/.

Previously noted, there were two variations of *Let's Know!* which differed in their breadth of language skills targeted. A Broad version targeted grammar, vocabulary, inferencing, comprehension monitoring, and text-structure knowledge whereas a Deep version targeted primarily vocabulary and comprehension monitoring. A comparison of the effects of the Deep and Broad variations on targeted language skills for children in grades one to three showed no clear pattern of differentiation among the two (Language and Reading Research Consortium et al., 2017b), with an exception being for vocabulary

knowledge. In general, children who received the Deep version out-performed those in the Broad version on their knowledge of words targeted during the 25-period of instruction. In the present study, for the purposes of parsimony, we collapsed both treatment conditions into a single *Let's Know!,* given our interest in examining the effects of *Let's Know!* on reading comprehension via children's language skills.

Fidelity of implementation to *Let's Know!* was measured in two primary ways. First, teachers maintained written logs of their daily implementation of lessons, and these were collected by staff regularly. Examination of logs by project staff showed that, on average, 68 of 85 total lessons (80%) were implemented (range: 8% ~ 100%). Second, research staff conducted seven observations per teacher across the academic year for randomly selected *Let's Know!* lessons. Staff coded for the absence or presence of 12 key features of lessons using a fidelity checklist developed for this purpose. Across all observations conducted (n = 635), teachers implemented an average of 9 of the key features (range: 2~10). As with many large-scale classroom-based interventions, fidelity did not achieve the gold standard of implementation and there was a high level of variability across teachers (Bleses et al., 2017). Thus, the present study represents intervention effects achieved in less-than-ideal implementation.

Business-as-Usual condition. Teachers in the BAU condition were asked to maintain their typical approach to language-arts instruction over the academic year. To address potential Hawthorne effects, BAU teachers completed study activities that paralleled those in the treatment condition, to include participating in an approximate amount of PD, receiving stipends, having classroom observations conducted in their classrooms, and completing curriculum-aligned study measures for their students, even

though in the BAU classroroms these were not actually aligned to the language-arts curriculum. The major distinction between teacher experiences across the treatment and BAU conditions is that the latter teachers did not receive the *Let's Know*! materials (e.g., lesson plans, storybooks) nor training in their use, and they were not observed for fidelity to the *Let's Know*! lessons.

Measures

Of primary interest in the present study are measures of students' language skills and reading comprehension. Two types of measures were used to represent potential effects of *Let's Know!* on children's skills. First, curriculum-aligned measures (CAMs) that were closely aligned to the intervention's scope and sequence were collected at the end of each instructional unit by children's teachers. Second, a distal measure of children's reading comprehension was conducted in the fall and spring of the academic year by research staff.

Curriculum-aligned measures (CAMs). CAMs were administered by teachers across the academic year and served as proximal measures of Let's Know! effects on children's skills in three areas: comprehension monitoring, vocabulary, and text comprehension. CAMS were administered by children's teachers near the end of the first through fourth units (week 6, week 13, week 20, week 24) following standardized scripts and scoring instructions. Teachers also were provided training on implementing the CAMs via a narrated PowerPoint training completed prior to implementing the first CAM. Extensive pilot work was done prior to field implementation to ensure that teachers could reliably score the CAMs. Note that CAMs were conducted by both treatment and control teachers. Sum scores of each measure were computed within grade

to be used as proximal outcomes in the analyses.

Comprehension Monitoring. A comprehension monitoring measure was used to assess children's ability to apply comprehension-monitoring strategies when listening to short passages containing incongruous information. Passages were aligned with the *Let's Know!* instructional content. In one-on-one sessions, teachers read the child two passages and asked the child to identify what did not make sense in the passage and to identify a fix-up strategy they could apply (e.g., re-read text). The teacher used a rubric to score each item as correct (2 points), correct after prompting (1 point), or incorrect (0 points). The maximum possible points was four per unit and 16 over four CAM assessments. Reliability as measured by ordinal alpha was 0.85.

Vocabulary. A vocabulary measure was used to assess children's knowledge of vocabulary words taught across the four *Let's Know!* units. Words taught and tested were selected based on their prevalence in children's books featured in *Let's Know!* lessons, importance for understanding unit content, and relevance to a variety of learning contexts (e.g., reading, math, science). All words were lower-frequency words. For each of four separate administrations, corresponding to the close of each of four units within the *Let's Know!* classrooms, teachers asked children to provide a definition of each of eight target words, and teachers rated responses as correct (2 points), partially correct (1 point), or incorrect (0 points) using a scoring protocol that listed acceptable answers. The maximum possible points was 16 per unit and 64 over four CAM assessments, and reliability was very high (alpha = 0.96).

Text comprehension. A text comprehension measure (also referred to as 'undertstanding text') was used to assess children's ability to apply inferencing skills to

comprehend narrative and expository text. Children listened to passages that were narrative or expository in nature and then answered three comprehension questions; each was scored as correct (1 point) or incorrect (0 points), for a total of 12 possible points across CAMs for narrative passages, and eight possible points for expository passages. The text comprehension measure at the end of Unit 1 and 4 used narrative text, whereas the measure after Unit 2 and 3 featured expository text. The content of the expository passages mirrored the units in terms of the general topic and text structure of focus (e.g., compare/contrast, cause/effect), whereas the comprehension questions required children to identify the main ideas or supporting details. Reliability was 0.71 for the overall scale.

Distal measures: Reading comprehension. Reading comprehension was assessed using an adaptation of the *Qualitative Reading Inventory-5* (Leslie & Caldwell, 2011), hereafter referred to as the Reading Comprehension Measure (RCM), and the *Gates-MacGinitie Reading Tests, 4th Edition* (Gates; MacGinitie et al., 2000). These were individually administered to each child by research staff in the fall and spring of the academic year, prior to and following implementation of *Let's Know!*. The RCM contained three narrative passages adapted from the original instrument and three expository passages created for the purpose of this project. Depending on the grade level, each child read narrative and expository passages silently, and then answered a series of comprehension questions. For example, first graders read the narrative story "A Mouse in a House" and were asked six questions (e.g., "Where did the mouse live in the house?"). They then read the expository passage "Cats" and answered four questions (e.g., "How are cats and dogs alike?"). Likewise, children in grade 2 and grade 3 read two grade-specific passages and answered different sets of questions (grade 2: ten narrative and

seven expository questions; grade 3: eight narrative and seven expository questions). All responses were audio-recorded and post-scored (0 or 1 point for each question) by research staff. The maximum possible points vary depending on the grade level. Interrater reliability of scoring was high (.93), and reliability for our sample was good (Cronbach's alpha = .76, .77, and .80 for grades 1 through 3).

The Gates is a commonly used measure that includes narrative and expository text segments. There are three levels to this test which correspond to grade levels 1-3. For grade levels 1-2, each text segment is accompanied by a panel of three pictures, and the child's task is to choose the picture in each panel that illustrated the segment or that answered a question about the segment. For grade 3, comprehension items are provided in the form of text instead of pictures. A total of 39 items were administered to grade 1 and grade 2, and 48 items were administered to grade 3. Reliability (Cronbach's alpha) was reported to be 0.92, and was high for our current sample (0.89~0.92). Criterion validity was also adequate, as evidenced by the correlation between Gates and standardized tests (correlation with Iowa Test of Basic Skills was .77; correlation with TerraNova Comprehensive Test of Basic Skills was .79 per the test manual). Raw scores of Gates were used in the current study.

Additional measures. Additional measures relevant to the current study included child and teacher demographics and other pretest assessments. These were used to assess differential attrition and initial equivalence, and a select number of measures were included as covariates in analyses. At the beginning of the academic year, children's caregivers completed questionnaires that reported basic demographic and family background. Teachers also completed similar questionnaires involving information on

teacher, classrooms, and schools. During the first 3- to 4-weeks, children completed pretest assessments administered by research staff, on a number of cognitive measures aligned to similar constructs as the CAMs. These included measures of *Let's Know!* vocabulary and the *Test of Narrative Retell: School-Age* (TNR; Petersen & Spencer, 2012). Specifically, the vocabulary measure mirrored the *Let's Know!* Vocabulary CAM probe except that it included only 16 targeted vocabulary words (four from each unit). In addition, the TNR was implemented to evaluate children's narrative skills at baseline, which serve as important control variables for children's initial skills. In the test, narrative retells were audio-recorded and scored for a variety of story grammar elements (interrater reliability = .86~.95). The total possible points for the story grammar composite was 36 (G1) or 56 (G2-G3).

Analytical Approach

Prior to conducting the primary analyses, we examined attrition and initial equivalence across conditions for each of the three grades. Attrition rates and initial equivalence was assessed on select demographic and pretest variables using Chi square tests (for categorical data) and independent samples *t* tests (for continuous data; Welch's tests when homogeneity of variance was violated). Variables tested included child characteristics (age, gender, ethnicity, home language, IEP status, caregiver's highest level of education completed), teacher characteristics (ethnicity, years of experience), classroom features (school type, use of curricula, class size) and children's pretest skill levels (vocabulary, grammar, reading comprehension measures). Variables identified as non-equivalent at baseline were included in all subsequent analyses as covariates, including pretest skills in vocabulary and a narrative task. Details of the attrition and

equivalence analyses are described in the Results section.

To evaluate the effects of *Let's Know!* on the proximal measures (CAMs), we conducted multilevel multivariate regression with CAM scores serving as outcomes of interest (Figure 1). Since CAMs were administered at multiple time points over the academic year, and CAM items varied across the three grade levels, we treated each grade as a separate sample and analyzed sum scores combined across units. A multilevel (mixed) model was applied, in which classroom effects were treated as random components, to account for the nested data structure. For each grade, treatment effects were estimated for all proximal measures simultaneously using multivariate modeling to account for the correlation between outcomes.

To test the effects of *Let's Know!* on the distal outcome of reading comprehension, we employed multilevel structural equation modeling (SEM) to model cascading pathways, specifically the effects of *Let's Know!* on four proximal outcomes (CAMs) and in turn their influence on reading comprehension, represented by a latent construct measured by three observed indicators (Figure 2). We hypothesized that the effects of *Let's Know!* on reading comprehension would be completely mediated by children's improvements in targeted language skills as represented by the CAMs. To appropriately assess the unique contribution of *Let's Know!*, we controlled for demographics (child gender, age, minority status, caregivers' highest level of education) as well as pretest vocabulary and narrative (TNL) scores, in both proximal and distal outcomes. Given the 2-1-1 data structure (i.e., random assignment to conditions occurred at the classroom level, whereas outcomes were measured at the child level), we followed the procedures suggested by Preacher, Zyphur, and Zhang (2010) to estimate the indirect

pathways (*ab*) in the model. Fit of the structural equation models was assessed with Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Standardized Root Mean Square Residual (SRMR). Since the conventional fit index, namely the chi-square fit statistic, tends to be very sensitive to sample size, it is preferable to take into account multiple indices of model fit to evaluate the adequacy of the model. Generally, models were considered an acceptable fit for the data if the SRMR and RMSEA were less than .08, and the CFI was at least .90 (Hu & Bentler, 1999; MacCallum, Browne, & Sugawara, 1996). In addition, we tested mediation models controlling for potential differences between the *Let's Know!* Broad and Deep conditions. The results were robust to the addition of the condition variable for all grade levels, and suggested that intervention variation did not led to significant differences in the process models. We therefore report here the models combining the two *Let's Know!* conditions.

The primary analyses to estimate relations and assess model fit were conducted in Mplus 7.11 (Muthén & Muthén, 1998-2010). The significance of the standardized path coefficients was determined by comparing the *z* ratio to a critical value at 0.05 level. Aside from statistical significance, we further estimated effect sizes (*d*) following the guidelines recommended by the What Works Clearinghouse.

Missing Data

The analytic sample included 938 children who had data on at least one out of the seven outcome measures. Of these 938 children, 587 (70%) had complete data on all outcomes. The percentage of missing data ranged from 2% to 8% for demographic variables, and 0% to 4% for other pretest assessments. Missing data were treated using multiple imputation (MI; Little & Rubin, 1987). Inclusive imputation (Schafer & Olsen,

1998) was conducted separately for each grade, such that MI models included all proximal and distal measures, as well as other variables theoretically or empirically related to the outcomes or missingness, based on the analyses of attrition and initial equivalence described above. Ten datasets were imputed in Blimp 6.6 (Keller & Enders, 2017) for each grade using multilevel (mixed-effects) linear models, in which classroom effects were treated as random components. These imputed datasets were then analyzed via the MI module in Mplus, from which ten sets of results were obtained and combined to generate the final estimates.

Results

Attrition and Initial Equivalence

A total of 938 out of 997 children (94.1%) had data on at least one outcome variable at any time point and were retained in the analytic sample. Out of the 59 children removed from the sample, the majority of attrition (n = 38, 64.4%) was due to teacher withdrawal, such that children were loss from the study if their teacher left the study. The percentage of teacher withdrawal rate did not differ significantly by condition (12.7% and 12.5%). The rest of the students attrited due to findings of ineligibility post-enrollment (n=5), difficulty in data collection (n=6), parents' withdrawal of consent (n=4), or school transfer (n=6). Overall, the student attrition rate was slightly higher for the *Let's Know!* classrooms (7.0%) than for BAU classrooms (3.8%) (p = .045). Further tests showed that there were no significant differences between the analytical sample and attrited sample in terms of child demographics, child baseline performance in selected measures (Let's Know! Vocabulary and TNR narrative), teacher characteristics (ethnicity and years of experience), or classroom-level features (grade level, class size, school type,

and curriculum used).

Initial equivalence across study conditions for both classroom- and child-level factors was assessed for each grade. No significant classroom-level difference was detected. As for child-level characteristics, children from the BAU and treatment classrooms did not differ in terms of gender, age, race, ethnicity, parental education, home language, IEP status, or children's pretest scores on the reading comprehension measures. However, some significant differences existed between conditions on other pretest measures, such that children assigned to the treatments condition scored significantly higher on *Let's Know!* vocabulary as compared to those in BAU at pretest (p = .028 in G1, .001 in G2, .011 in G3). In G3, children also showed initial differences on a narrative task (p = .015) that favored the treatment condition. Non-equivalent variables were subsequently used as covariates in the primary analyses.

Correlation coefficients among all outcome variables are displayed in Table 3. With the exception of the correlation between comprehension monitoring and vocabulary (.51~.66), correlation among the proximal measures was relatively low (average r = .30), as was the correlation between proximal and distal measures (average r = .292).

Effects of *Let's Know!* on Language Skills

To investigate the effects of *Let's Know!* on language skills, representing outcomes proximal to the intervention, we conducted multilevel multivariate regression analyses. For each grade level, we simultaneously estimated the impact of *Let's Know!* on four curriculum-aligned measures, namely comprehension monitoring, *Let's Know!* vocabulary, and text comprehension (narrative and exposity). We also included as covariates the aforementioned demographic variables and pretest measures on which

conditions appeared to initially differ. Estimated coefficients of treatment as well as their effect sizes (*d*) are summarized in Table 4.

Comprehension Monitoring. The intraclass correlation (ICC; generated from the unconditional model) ranged from 0.29 (G3) to 0.54 (G1) across grades for the comprehension monitoring sum scores. This indicates that a substantial amount of variation can be accounted for by classroom differences. After controlling for covariates, an additional 15% (G3) to 39% (G1) of the variance was accounted for by condition. Overall, *Let's Know!* had a positive effect on comprehension monitoring scores, in that students in *Let's Know!* significantly outperformed those assigned to the control condition by 2 to 5.5 points, out of a maximum of 16. The effect size was large for grade 1 (1.24), and moderate for grade 2 (0.71) and grade 3 (0.55).

Let's Know! Vocabulary. The ICC for the Let's Know! Vocabulary measure ranged from 0.72 (G2) to 0.78 (G1), implying that classroom differences contributed vastly to the variation in vocabulary scores. An additional 38% (G3) to 58% (G2) of the variance was attributable to study condition beyond what was accounted for by covariates. On average, children from classrooms implementing *Let's Know!* significantly outperformed those in BAU classrooms by 23 to 27 points (out of a maximum of 64). The effect size was large across grades ($d > 1.98$).

Text Comprehension. The ICC for scores on the narrative text comprehension measures ranged from 0.24 (G3) to 0.42 (G1). After controlling for covariates, condition further accounted for an additional 2% to 7% of variance in total scores. While a significant, positive effect was observed in grade 3 ($b = 0.50$, $p = 0.033$, $d = 0.33$), no statistical differences or sizeable effect size were found between control and intervention

classrooms in grade 1 or grade 2. With respect to expository text comprehension, for the sum scores the ICC ranged from 0.15 (G3) to 0.20 (G1, G2). Condition contributed negligible amount of extra variance (<2%) after controlling for covariates. Children assigned to *Let's Know!* classrooms showed no significant differences than those assigned to control classrooms, and all effect sizes were negligible.

Indirect Effects of *Let's Know!* on Reading Comprehension

To test the impact of *Let's Know!* on reading comprehension, we conducted multilevel path analyses based on the theory of change depicted in Figure 2. Since reading comprehension was treated as a latent variable in the model, we first validated the construct via two-level confirmatory factor analyses (CFA) prior to the primary analyses. Across all grades the model fit was satisfactory (RMSEA < .08; CFI > .95; SRMR < .08).

We then investigated whether Le*t's Know!* exerted an indirect effect on reading comprehension through its influence on language skills, as represented in the CAMs. As shown in Table 5, the theoretical model fits the data reasonably well (RMSEA = .047~.079; CFI = .901~.951; SRMR within = .026~.028; SRMR between = .054~.075). As reported previously, *Let's Know!* significantly impacted children's performance on comprehension monitoring and vocabulary across all three grade levels, and had a positive effect on narrative text comprehension in grade 3 only. Out of the four proximal outcomes, children's performance on *Let's Know!* Vocabulary consistently predicted reading comprehension ($p < .001$), whereas scores of expository text comprehension were associated with reading comprehension only in grade 1 ($p = .042$) and grade 2 ($p = .025$).

The indirect effects of *Let's Know!* on reading comprehension were

simultaneously estimated along with the pathways from predictor to mediators (*a*) and mediators to outcomes (*b*) via the product of the pathways (*ab*). For all three grades, *Let's Know!* significantly impacted reading comprehension via the mediation of vocabulary (*ab* = 0.72~1.03, $p < .05$), with sizable effects (*d* = 1.89~2.26). However, other indirect pathways were non-significant.

Discussion

Reading comprehension is a multi-component skill that is influenced by both decoding and language comprehension (Hoover & Gough, 1990). Among skilled readers, language skills explain a greater amount of variance in reading comprehension than decoding (Language and Reading Research Consortium & Logan, 2017), leading to considerable efforts to identify strategies for improving those language skills that contribute most strongly to skilled reading comprehension. The investigation presented here was designed to leverage the relations between language skills and reading comprehension as a means for improving the latter. In all three grades, the language-focused *Let's Know!* intervention impacted reading comprehension via the mediation of vocabulary, with sizable effects. These results converge with a small but growing line of research showing that explicit instruction focusing on lower- and/or higher-language skills can positively impact those target skills and have an indirect contribution to reading comprehension as well (e.g., Clarke et al., 2010; Williams et al., 2004, 2009).

The findings of this work have practical as well as theoretical appeal. With respect to practical implications, *Let's Know!* is a multi-component curricular supplement that targets a variety of language components rather than focusing on one specific language component (e.g., vocabulary). A review of the extant literature indicates there

are few programs that are specifically designed to explicitly address multiple components of oral language (but see Clarke et al., 2010; Williams et al., 2009). One potential benefit of instructing on a variety of skills is that it is currently unclear which domains of language are most influential to skilled reading comprehension. Research reports suggest that an array of lower- and higher-level skills contribute to reading comprehension, including grammar, vocabulary, text-structure knowledge, comprehension monitoring, and inferencing (Cain & Oakhill, 1999; Cain et al., 2001; Clarke et al., 2010; Williams et al., 2014; Williams et al., 2009). *Let's Know!* was designed in such a way that the explicit skills targeted were interspersed throughout an entire academic year and were targeted relatively deeply. Research has shown that learning opportunities that are distributed across time are an advantageous way to provide learning opportunities to students (e.g., Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006).

Although some prior studies have shown that targeting language skills can elevate primary-grade students' reading comprehension (Clarke et al., 2010), an additional practical implication of this study is the finding that language-focused intervention can be delivered as whole-class instruction and as a complement to, rather than replacement of, the existing language-arts curriculum. While some studies have evaluated language-focused interventions implemented as part of whole-class instruction in the primary grades (Coyne, McCoach, & Kapp, 2007; Coyne et al., 2010; Williams et al., 2004), such studies have generally focused only on one targeted language skill and have limited outcome measures to the targeted language skills without examining potentially indirect effects on reading comprehension. The present results suggest that primary-grade teachers can provide explicit, systematic instruction targeting language skills –

vocabulary skills, comprehension monitoring, and text comprehension – which in turn can elevate children's reading comprehension via mediating pathways.

However, also relevant to considering these practical implications is that many students in this study did not receive the full *Let's Know!* intervention due to low levels of implementation by some teachers. For instance, we reported that an average of 80% of lessons were implemented with significant range across teachers (8% to 100%). This suggests that some primary-grade teachers may require support when implementing *Let's Know!* or similar language-focused interventions. Evolving research on effective avenues for coaching and mentoring teachers suggests that a variety of methods may be effective for improving implementation, such as situated coaching models embedded in the classroom (Friedman & Woods, 2015) and telecoaching using bug-in-the-ear technologies (Schaefer & Ottley, 2018).

Theoretically, this experiment further solidifies the critically important contribution of language skills to reading comprehension, as indoctrinated in the simple view of reading (Hoover & Gough, 1990) and supported in a large number of correlational studies (e.g., Catts, Adlof, & Weismer, 2006; Kershaw & Schatschneider, 2012; Tunmer & Chapman, 2012). The simple view of reading proposes that reading comprehension is a product of decoding and language comprehension, with language comprehension becoming more influential to reading comprehension as the reader matures and becomes a more fluent decoder (Language and Reading Research Consortium, 2015). There have been relatively few experimental tests of the influence of language skills on reading comprehension, with work by Clarke and colleagues (2008) a notable exception. In that study, primary-grade students with reading-comprehension

difficulties received explicit, systematic language-focused instruction thrice weekly in 30 minutes sessions for 20 weeks. Although reading comprehension was not explicitly taught, and children did not work with written texts, they showed a significant improvement in reading comprehension relative to children in two counterfactual conditions; moreoever, these positive effects persisted to nearly one-year later. That study provided convincing evidence of the causal role of language skill in reading comprehension. However, with the intervention delivered in pairs or individually by trained research staff, it was unclear whether such work could generalize to whole classes of students and language-focused intervention being delivered by the public-school teacher. Thus, the results of this study have both theoretical and practical utility.

A few ancillary matters regarding the present experiment warrant note and help to highlight future research directions. First, assessment of teachers' implementation of *Let's Know!* in this study yielded findings similar to other larger-scale studies, in that overall implementation was moderate (Bleses et al., 2017; Pianta, Mashburn, Downer, Hamre, & Justice, 2008). As described earlier, *Let's Know!* lessons were "soft-scripted," in that teachers were provided with a specific order in which to introduce material, wording suggestions to introduce new concepts, and multiple examples to utilize during the lessons. This level of scriptedness paired with initial professional development and ongoing support from LARRC staff was thought to provide sufficient guidance for effective implementation, but results from this study align with others in that improving teachers' language-focused instruction is difficult (Cabell et al., 2011). Thus, it is possible that the potential benefits of *Let's Know!* on student outcome were not fully realized because teachers were not implementing all aspects of the intervention. This

might have particular relevance to providing instruction in text comprehension, which is a higher-level language skill that might pose challenges for some teachers. Future work should attempt to identify supports that would increase implementation fidelity while also monitoring whether such an increase would lead to additional positive impacts on student outcomes. Additionally, it would be useful to determine whether certain aspects of *Let's Know!* were more or less used by teachers or presented specific challenges for implementation.

Second, despite targeting text comprehension in the language-focused intervention, analyses showed a lack of effects across grades on the text comprehension tasks (expository and narrative CAMs). Possibly, this is due to the intervention design, in which we included attention to both narrative and expository text comprehension within the intervention. We chose to include both types of text in order to provide exposure to critical skills related to reading comprehension. Reading narratives to young children is an engaging activity commonly utilized in elementary classrooms and provides teachers an opportunity to teach children important story grammar elements as well as expose them to rich and complex language. Expository texts build crucial background knowledge that assists with text comprehension and include a wide variety of text structures, including compare/contrast, problem/solution, and cause/effect (Williams et al., 2004). Research has shown that primary grade students are not exposed to expository text as often as narrative texts (Duke, 2000), but this is the type of text most commonly used as students advance into upper elementary grades and beyond. Our research team felt strongly that exposing students to both types of text was a critical component of *Let's Know!,* but it is possible that because explicit instruction was split between the two types

of text, students did not receive the intensity that was necessary to afford changes in this skill. Future research should consider whether instruction on both expository and narrative texts in each unit would lead to increased benefits.

Third, it is especially important to highlight the strong mediating role of vocabulary skills in affecting students' reading comprehension. At every grade, we found that *Let's Know!* affected students' reading comprehension significantly via the pathway of improved vocabulary. This finding builds upon work presented by Beck and colleagues more than 30 years ago, in which they found that directly teaching a relatively small set of lower-frequency but "useful and interesting" words to fourth graders had a significant, positive effect on reading comprehension (Beck et al., 1982). Similar to the methods used in *Let's Know!,* Beck et al's intervention featured repeated, direct instruction targeting many elements of lexical representation (e.g., phonology, orthography, morphology) for a small set of 104 words. In their interpretation of the 'transfer effect,' such that vocabulary intervention resulted in effects on reading comprehension, the authors suggest that the intervention may have increased students' general word-learning capabilities, thus leading to overall improved vocabulary breadth and depth, or an overall general learning factor; put simply, perhaps children receiving the vocabulary intervention became better learners. Although Beck et al suggested that their experiment made distinguishing between these two possibilities not possible, the results of the present study suggest that improving children's overall word-learning capabilities may be the more plausible explanation. That is, although children in *Let's Know!* appeared to be overall better learners, as captured by improved performance on the comprehension monitoring CAMs, the improvements in targeted vocabulary appeared

to play a decisive role in transfer effects of the intervention to reading comprehension. Further investigations of the impact of vocabulary-focused interventions on reading comprehension are warranted as a result of this finding.

Several limitations of this work warrant note. First, teachers enrolled in the study were self-selected, and thus may differ in important ways from teachers who would not select into such a study. This should be considered when making strong causal interpretations from this study. Second, our CAMS, representing key proximal outcomes in this study, were developed for the purpose of this intervention and investigation. While considerable efforts were undertaken to enhance their psychometric characteristics, they may not function as strongly as more well-tested measures. Third, we were not able to address the sustainability of observed gains in student outcomes following the end of the year of involvement in the study. Ideally, research could provide information about the extent to which students maintained learned skills, as Clarke and colleagues did in their 2010 investigation of language-focused interventions for children with reading-comprehension difficulties. Finally, in relation to the implementation fidelity of *Let's Know!,* it was past the scope of this study to examine teacher characteristics that lead to increased fidelity of implementation. Future research should attempt to identify if such characteristics exist.

Despite these limitations, this study has shown that implementing a language-focused curriculum in the primary grades has the potential to improve children's language skills, specifically vocabulary and comprehension monitoring, as a vehicle to improving reading comprehension. This is one of first studies to examine student outcomes of such instruction implemented by teachers, not research staff, in a classroom

setting and within the context of whole-class instruction. The promising results provide an impetus for ongoing investments into leveraging students' language skills as a route for improving reading comprehension, to include further investigations of the benefits of *Let's Know!* for students who are struggling with language or reading growth.

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Table 1
Overview of Let's Know! lesson s within a unit by condition

Lesson Type	Description	Number of lessons [a]	
		Broad	Deep
Hook	Designed to capture children's attention and provide an overview of the unit and final project.	1	1
Read to Me	Designed to promote children's exposure and engagement with rich text, opportunities to engage in rich discussions, use higher-level inferential language and comprehension monitoring skills.	3	3
Words to Know	Designed to build children's knowledge and use of unit vocabulary words.	4	4
Words to Know Practice	Additional Words to Know lessons.	0	4
Text Mapping	Designed to target objectives related to the production and comprehension of different grammatical structures including recasting, think alouds and navigational words.	4	0
Integration	Designed to provide children with an opportunity to learn and practice retelling, inferencing strategies and finding the main idea to help them become more strategic readers.	4	4
Integration Practice	Additional Integration lessons.	0	4
Read to Know	Designed to promote children' engagement with reading by allowing them the autonomy to make decisions about what they read and helping them to select texts that are of interest to them.	4	0
Show Me What You Know (CAM)	Teachers administer the CAMs to the study-selected children. Results are used to inform the Stretch & Review lessons. Time to practice CAMs was also incorporated into each unit.	1	1
Stretch & Review	Developed by the teachers based on CAM results, designed to individualize instruction and either review key concepts or delve deeper into unit topics.	2	2
Close	Designed to provide children a hands-on experience in which they can integrate the skills and knowledge developed over the unit.	1	1

Note. [a] For the last unit (Folktales), the number of lessons were reduced but followed the same pattern. CAM = curriculum-aligned measure.

Table 2
Descriptive information by condition and grade for the analytic sample (N=938)

	Grade 1 (*N* = 326)					
	Control			Let's Know!		
	n	%		*n*	%	
Children (classrooms)	110 (19)			216 (39)		
Attrition rate of children (classrooms) [a]		4.3 (20.8)			4.4 (11.4)	
Teacher/Classroom characteristics						
Teacher minority status	4	22.2		3	13.9	
Public school	19	100.0		31	91.2	
Use of state-developed curricula	12	66.7		24	66.7	
Use of locally-developed curricula	14	77.8		29	80.6	
Use of commercial curricula	12	66.7		26	72.2	
Child characteristics						
Female	53	48.2		116	53.7	
Minority status (non-White/Hispanic)	36	36.0		82	40.6	
Primary home language: English	73	91.3		134	91.8	
IEP status	9	8.8		23	11.3	
Parent HD: High school/GED	37	35.9		91	42.9	
Parent HD: Associates/Bachelors	39	37.9		60	28.3	
Parent HD: Graduate	16	15.5		38	17.9	
	Mean	*SD*	Range	Mean	*SD*	Range
Teacher/Classroom characteristics						
Teacher years teaching current grade	10.53	7.88	1~33	11.44	7.54	1~30
Class size	21.21	2.66	18~27	21.19	4.52	13~30
Child age (months)	82.56	6.31	72~98	82.10	6.43	65~108
Child pretest scores						
Let's Know! Vocabulary	4.14	3.63	0~17	5.20	4.24	0~20
TNR story grammar	12.84	6.69	0~26	12.93	7.34	0~26
Gates	20.08	8.81	6~37	18.72	8.02	3~36
RCM narrative	2.15	1.36	0~5	2.30	1.45	0~6
RCM expository	1.84	1.21	0~4	1.77	1.18	0~4
Child proximal outcomes (sum score) [b]						
Comprehension Monitoring	6.13	5.15	0~16	11.87	4.06	0~16
Let's Know! Vocabulary	14.43	8.55	1~39	45.44	13.60	1~64
Understanding Narrative Text	9.48	2.46	2~12	9.90	2.14	0~12
Understanding Expository Text	4.16	1.73	0~8	4.59	1.76	0~8
Child distal outcomes (posttest) [b]						
Gates	29.18	7.79	8~39	28.06	7.86	6~39
RCM narrative	3.55	1.48	0~6	3.45	1.54	0~6
RCM expository	2.85	1.15	0~4	2.76	1.14	0~4

Table 2 (cont'd)
Descriptive information by condition and grade for the analytic sample (N=938)

	Grade 2 (*N* = 325)					
	Control			Let's Know!		
	n	%		*n*	%	
Children (classrooms)	110 (18)			215 (36)		
Attrition rate of children (classrooms) [a]		7.0 (10.0)			9.7 (12.2)	
Teacher/Classroom characteristics						
Teacher minority status	0	0.0		3	8.6	
Public school	16	94.1		34	97.1	
Use of state-developed curricula	13	76.5		19	54.3	
Use of locally-developed curricula	13	76.5		29	82.9	
Use of commercial curricula	12	70.6		22	62.9	
Child characteristics						
Female	63	53.7		108	50.2	
Minority status (non-White/Hispanic)	34	31.5		57	36.1	
Primary home language: English	80	96.4		151	94.4	
IEP status	7	6.5		20	9.4	
Parent HD: High school/GED	42	39.3		74	34.9	
Parent HD: Associates/Bachelors	40	37.4		89	42.0	
Parent HD: Graduate	19	17.8		40	18.9	
	Mean	*SD*	Range	Mean	*SD*	Range
Teacher/Classroom characteristics						
Teacher years teaching current grade	11.76	7.06	2~27	12.01	7.11	1~25
Class size	21.65	2.94	17~29	21.57	2.93	15~28
Child age (months)	95.75	7.76	83~131	94.73	6.93	80~121
Child pretest scores						
Let's Know! Vocabulary	4.44	2.84	0~18	5.73	3.71	0~21
TNR story grammar	19.27	9.51	0~51	19.10	7.77	0~36
Gates	25.43	8.36	7~38	25.66	7.89	5~37
RCM narrative	5.88	2.35	0~10	5.77	2.38	0~10
RCM expository	3.98	1.95	0~7	3.75	2.04	0~7
Child proximal outcomes (sum score) [b]						
Comprehension Monitoring	8.85	3.20	1~16	11.92	3.60	0~16
Let's Know! Vocabulary	15.38	7.57	1~35	41.71	13.44	0~63
Understanding Narrative Text	10.19	1.93	4~12	9.92	1.98	2~12
Understanding Expository Text	5.14	1.59	1~8	5.10	1.76	0~8
Child distal outcomes (posttest) [b]						
Gates	31.66	5.48	11~39	30.98	6.79	10~39
RCM narrative	7.47	1.65	3~10	6.93	2.11	0~10
RCM expository	4.74	1.47	0~7	4.33	1.75	0~7

Table 2 (cont'd)
Descriptive information by condition and grade for the analytic sample (N=938)

	Grade 3 (N = 287)					
	Control			Let's Know!		
	n	%		*n*	%	
Children (classrooms)	106 (18)			181 (30)		
Attrition rate of children (classrooms) [a]		3.6 (5.3)			6.7 (14.3)	
Teacher/Classroom characteristics						
Teacher minority status	0	0.0		5	16.7	
Public school	16	88.9		26	86.7	
Use of state-developed curricula	10	55.6		15	51.7	
Use of locally-developed curricula	14	77.8		21	72.4	
Use of commercial curricula	8	44.4		17	58.6	
Child characteristics						
Female	54	50.9		91	50.3	
Minority status (non-White/Hispanic)	26	25.5		51	29.1	
Primary home language: English	74	94.9		127	93.4	
IEP status	8	7.8		9	5.1	
Parent HD: High school/GED	28	27.2		67	37.2	
Parent HD: Associates/Bachelors	47	45.6		66	36.6	
Parent HD: Graduate	23	22.3		32	17.8	
	Mean	*SD*	Range	Mean	*SD*	Range
Teacher/Classroom characteristics						
Teacher years teaching current grade	8.89	7.39	1~26	8.63	6.99	0~23
Class size	22.06	4.19	8~27	22.37	3.14	16~30
Child age (months)	107.31	7.27	95~130	106.25	6.66	94~127
Child pretest scores						
Let's Know! Vocabulary	7.13	4.49	0~21	8.60	4.92	0~23
TNR story grammar	20.91	8.50	0~45	23.41	7.68	2~40
Gates	28.52	10.41	7~46	30.56	9.74	6~47
RCM narrative	3.95	1.90	0~7	4.09	1.79	0~8
RCM expository	4.23	1.98	0~7	4.57	1.98	0~7
Child proximal outcomes (sum score) [b]						
Comprehension Monitoring	10.79	5.04	0~16	13.35	3.20	0~16
Let's Know! Vocabulary	18.77	8.77	5~42	45.23	12.53	6~63
Understanding Narrative Text	10.16	1.70	5~12	10.89	1.34	6~12
Understanding Expository Text	5.23	1.66	1~8	5.19	1.63	0~8
Child distal outcomes (posttest) [b]						
Gates	34.38	9.06	8~47	34.94	8.52	12~48
RCM narrative	4.66	1.78	0~8	4.76	1.53	0~8
RCM expository	4.92	1.93	0~7	5.27	1.73	0~7

Note. HD: Highest degree; TNR: Test of Narrative Retell (Petersen & Spencer, 2012); Gates: Gates-MacGinitie Reading Tests, 4th Edition (MacGinitie et al., 2000); RCM: Reading Comprehension Measures (Leslie & Caldwell, 2011).

[a] Attrition rate of the initial sample (including analytical sample and the removed cases). For example, 4.3 (20.8) means that for Grade 1, control group, 4.3% of the initially recruited children attritted, and 20.8% of the initially recruited classrooms attritted.

[b] Maximum scores: Let's Know! Vocabulary (pretest) = 38; TNR story grammar pretest G1 = 36, G2 = 56, G3 = 56; Comprehension Monitoring = 16; Understanding Narrative Text = 12; Understanding Expository Text = 8; Let's Know! Vocabulary (sum score) = 64; Gates G1 = 39, G2 = 39, G3 = 48; RCM narrative: G1 = 6, G2 = 10, G3 = 8; RCM expository G1 = 4, G2 = 7, G3 = 7.

Table 3

Pearson correlation coefficients among student key outcomes by grade

		1	2	3	4	5	6
Grade 1	1. Comprehension monitoring	--					
	2. Vocabulary	.657	--				
	3. Understanding narrative text	.303	.352	--			
	4. Understanding expository text	.358	.327	.270	--		
	5. RCM narrative	.243	.305	.373	.290	--	
	6. RCM expository	.259	.279	.271	.207	.513	--
	7. Gates	.259	.344	.351	.379	.557	.595
Grade 2	1. Comprehension monitoring	--					
	2. Vocabulary	.615	--				
	3. Understanding narrative text	.352	.243	--			
	4. Understanding expository text	.337	.324	.295	--		
	5. RCM narrative	.318	.216	.366	.317	--	
	6. RCM expository	.169	.195	.254	.244	.447	--
	7. Gates	.346	.335	.267	.442	.433	.408
Grade 3	1. Comprehension monitoring	--					
	2. Vocabulary	.513	--				
	3. Understanding narrative text	.332	.382	--			
	4. Understanding expository text	.234	.233	.190	--		
	5. RCM narrative	.329	.317	.153	.161	--	
	6. RCM expository	.213	.361	.325	.174	.446	--
	7. Gates	.371	.480	.304	.287	.515	.493

Notes. Correlation coefficients are combined over 10 imputed datasets.

Table 4

Effects on language outcomes: Results of multilevel multivariate regression

	Grade 1 (n = 326)				Grade 2 (n = 325)				Grade 3 (n = 287)			
	coef.	*z*	*p*	*d*	coef.	*z*	*p*	*d*	coef.	*z*	*p*	*d*
Comprehension Monitoring												
Let's Know!	5.52	6.25	<.001	1.24	2.46	3.23	.001	0.71	2.18	2.97	.003	0.55
LK! vocabulary												
Let's Know!	26.95	11.74	<.001	2.23	23.46	10.89	<.001	1.98	24.10	12.45	<.001	2.14
Understanding narrative text												
Let's Know!	0.21	0.45	.653	0.09	-0.35	-0.97	.335	-0.18	0.50	2.13	.033	0.33
Understanding expository text												
Let's Know!	0.21	0.72	0.471	0.12	0.04	0.17	0.868	0.03	-0.08	-0.28	0.783	-0.05

Coef. = coefficient; *z* =ratio of the parameter estimate to its standard error, used for approximate z-test; *d* = child-level effect size computed in accordance with What Works Clearinghouse recommendations.

Note. Model estimates are combined over 10 imputed datasets. Significant comparisons ($p < .05$) bolded. Covariates are not shown in the table, but are included in the model. Covariates used include: children's scores on relevant pretest assessments (Let's Know! vocabulary, TNR story grammar), parent highest education level, child gender, age, and minority status.

Table 5

Effects of Let's Know! on proximal and distal outcomes: Results of multilevel path model

Model estimates	Grade 1				Grade 2				Grade 3			
	Coef.	*z*	*p*	*d*	Coef.	*z*	*p*	*d*	Coef.	*z*	*p*	*d*
Level 1												
CM → RC	-0.05	-0.59	.554		0.03	0.49	.621		0.02	0.32	.746	
VA → RC	0.79	6.32	<.001		0.56	4.27	<.001		0.73	6.56	<.001	
NR → RC	0.10	1.34	.180		0.04	0.63	.528		0.02	0.36	.716	
EP → RC	0.09	2.04	.042		0.12	2.24	.025		0.03	0.49	.627	
Level 2												
CM → RC	0.01	0.04	.967		0.05	0.19	.852		-0.11	-0.20	.846	
VA → RC	-0.08	-0.27	.791		-0.08	-0.63	.531		-0.08	-0.45	.656	
NR → RC	0.03	0.06	.950		0.44	1.92	.055		0.66	1.13	.260	
EP → RC	0.48	0.26	.792		-0.07	-0.16	.872		0.35	0.51	.610	
LK → CM	1.07	6.11	<.001		0.72	3.69	<.001		0.56	3.25	.001	
LK → VA	1.45	11.75	<.001		1.52	11.43	<.001		1.31	11.08	<.001	
LK → NR	0.17	0.74	.461		-0.20	-1.11	.267		0.31	1.98	.048	
LK → EP	0.04	0.20	.839		0.15	1.03	.301		-0.07	-0.39	.699	
Cross-level indirect effects												
LK → CM → RC	-0.04	-0.12	0.902	-0.09	0.05	0.28	.781	0.14	-0.06	-0.19	0.849	-0.12
LK → VA → RC	1.03	2.06	0.040	2.26	0.72	2.36	.018	1.89	0.85	3.34	0.001	1.89
LK → NR → RC	0.03	0.33	0.740	0.06	-0.09	-0.93	.351	-0.24	0.22	1.02	0.308	0.48
LK → EP → RC	-0.00	-0.01	0.990	-0.01	0.00	0.03	.973	0.01	-0.02	-0.25	0.802	-0.04

Model fit	RMSEA	CFI	SRMR		RMSEA	CFI	SRMR		RMSEA	CFI	SRMR	
			w/n	b/t			w/n	b/t			w/n	b/t
	0.079	0.901	0.026	0.063	0.072	0.921	0.027	0.075	0.047	0.951	0.028	0.054

Coef. = coefficient; *z* =ratio of the parameter estimate to its standard error, used for approximate z-test; d = child-level effect size computed in accordance with What Works Clearinghouse recommendations; w/n = within; b/t = between.

RC = reading comprehension (latent variable); CM = comprehension monitoring; VA = Let's Know! Vocabulary; NR = understanding narrative texts; EP = understanding expository texts; LK = Let's Know! treatment

Note. Model estimates are combined over 10 imputed datasets. Covariates are not shown in the table, but are included in the model. Covariates used include: children's scores on relevant pretest assessments (Let's Know! vocabulary, TNR story grammar), parent highest education level, child gender, age, and minority status.

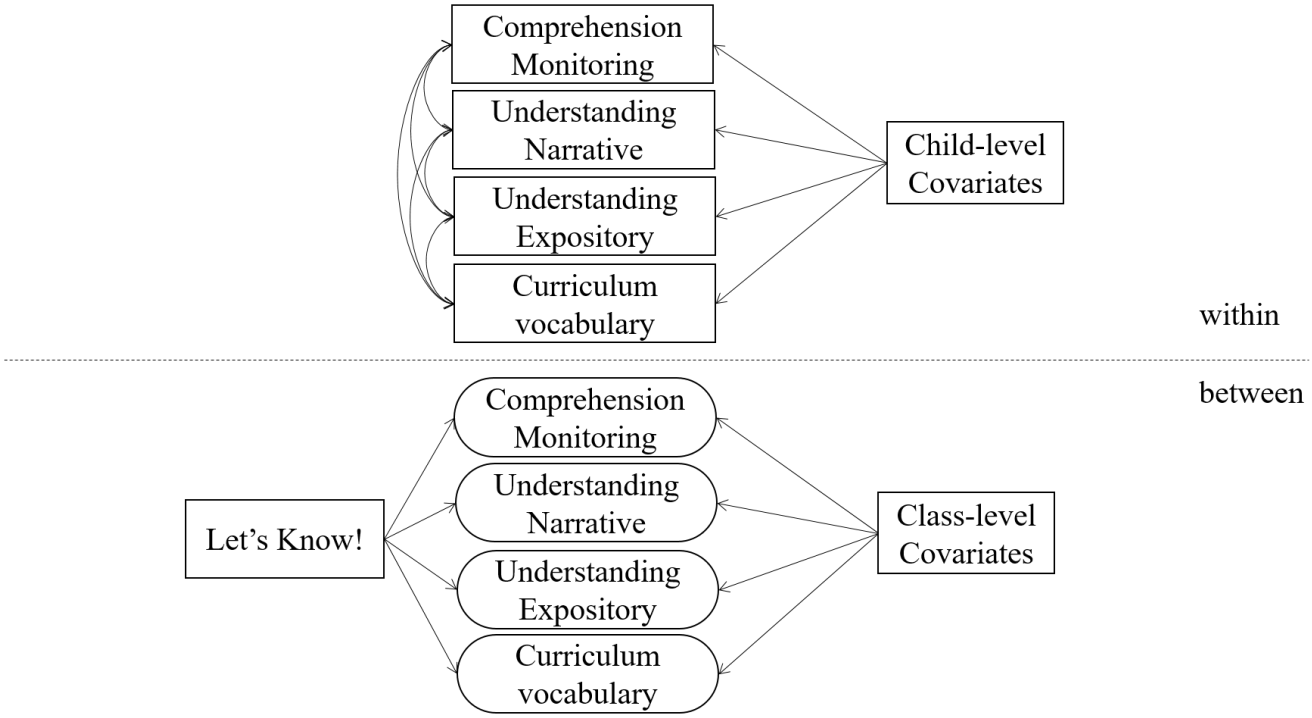

Figure 1 Diagram of multilevel multivariate regression to test the effects of Let's Know! on proximal outcomes (curriculum-aligned measures)

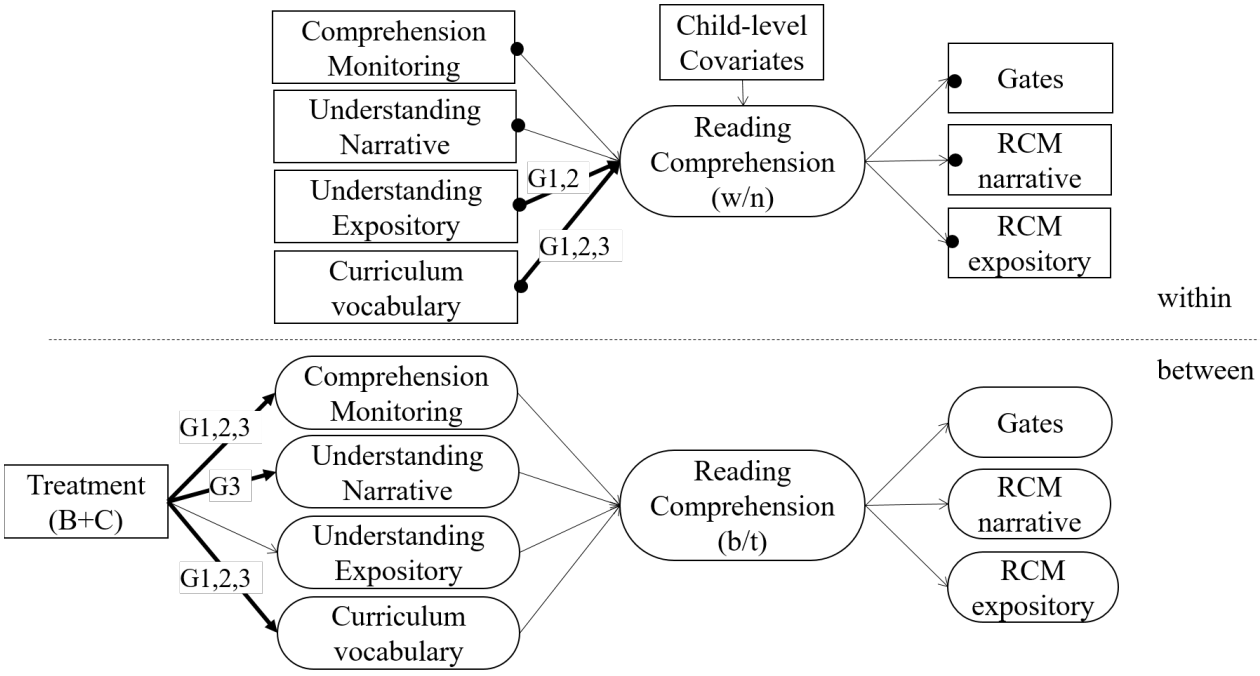

Figure 2 Diagram of multilevel path model to test the effects of Let's Know! on distal language outcomes (reading comprehension)

Notes. Covariates are included at both the child and classroom level, but for simplicity they are not shown in the diagram. Significant paths are boded and the grade levels for which the paths are significant are indicated.

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