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ORIGINAL PAPER

Improving the Language Skills of Pre-kindergarten Students: Preliminary Impacts of the *Let's Know!* Experimental Curriculum

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Abstract
Background Improving children's oral language skills is an important focus of educational research and practice; however, relatively few interventions have demonstrated impacts on these skills. This work makes a unique contribution to our understanding of the effects of language-focused interventions in pre-kindergarten settings by examining impacts on both lower- and higher-level language skills as well as overall language comprehension.
Objective The goal is to assess the impacts of business-as-usual pre-kindergarten with implementation of two versions of an experimental curriculum supplement, *Let's Know!,* designed to enhance three component language skills (vocabulary, comprehension monitoring, and text-structure knowledge) and overall language comprehension in pre-kindergarteners.
Methods Eleven pre-kindergarten teachers and 49 low socioeconomic-status students participated. Teachers were randomly assigned to either business-as-usual, *Let's Know!* Broad, or *Let's Know!* Deep, unless they participated in a previous pilot study, in which case they were randomly assigned to either *Let's Know!* Broad or Deep. The Broad version included five different lesson types, whereas the Deep version included three lesson types with additional practice. Children's gains were assessed proximally with measures of vocabulary, comprehension monitoring, and text-structure knowledge and distally with a measure of language comprehension.
Results Children in both experimental versions significantly improved their vocabulary skills relative to children who received business-as-usual instruction. For comprehension monitoring, children who received the Deep and Broad versions improved their scores relative to BAU children for Units 1 and 3, respectively. Improvement in language

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comprehension was only found for children who received *Let's Know!* Deep compared with business-as-usual.
Conclusion This study provides initial evidence that the *Let's Know!* curricula may serve to foster young children's vocabulary, comprehension monitoring, and language comprehension skills.

Keywords Oral language intervention · Vocabulary · Comprehension monitoring · Text-structure · Pre-kindergarten

Introduction

During the last decade, a large number of classroom-based language-focused programs and practices have been developed and tested for their impacts on pre-kindergarten (pre-K) children's oral language skills (Assel et al. 2007; Jackson et al. 2006; Justice et al. 2008; Lonigan et al. 2013; Mashburn et al. 2010; Piasta et al. 2010; Powell et al. 2010). Some of these interventions have involved provision of intensive professional development (PD) for pre-K teachers to promote their use of specific language-facilitating practices (e.g., Piasta et al. 2010; Powell et al. 2010), whereas others featured teachers' implementation of curricula providing an explicit scope and sequence of language-focused instruction (e.g., Justice et al. 2008; Lonigan et al. 2013). Regardless of approach, interests in improving young children's oral language skills stem from the well-established relations between children's early language skills and future academic achievement, particularly in reading comprehension (Storch and Whitehurst 2002). If children's language skills can be enhanced during the pre-K year, it stands to reason that this might have positive effects on children's future academic performance as a result.

An important finding from the language-intervention literature to date is that relatively few interventions appear successful in significantly elevating the language skills of young children. For instance, Powell and his colleagues studied the language growth of children in the classrooms of pre-K teachers who participated in a semester-long PD course involving workshop training plus in-class coaching. A major emphasis of the PD was to improve teachers' use of specific language-facilitating practices in the classroom, such as providing expansions of children's language use during conversations and read-alouds (Powell et al. 2010). A comparison of language growth over the academic year of children whose teachers who did not participate in the PD showed no advantage for those children whose teachers received extensive training in language-facilitating practices ($d = 0.03$). Other studies have reported similar findings, with teachers' use of specific curricula and/or receipt of PD having limited effects on children's language skills (Bierman et al. 2008; Cabell et al. 2011). Bierman et al. (2008) studied the effects of a multi-component enriched curriculum, including language-enrichment activities, for children in Head Start; the intervention had little discernable effects on children's language skills (ds $= -0.07$ to 0.15). Likewise, Cabell et al. (2011) studied the effects of teachers' use of language-facilitating strategies they learned in PD for at-risk preschoolers; effects of the intervention on children's language skills was also quite modest (ds $= 0.05$–0.13).

Meta-analyses of vocabulary-specific interventions have found few specific intervention features that appear to contribute to large impacts on child outcomes, components of which included teacher or experimenter implementation, or use of explicit or implicit instruction

(Marulis and Neuman 2010, 2013). Indeed, few interventions were able to reduce a poverty-induced achievement gap. However, some vocabulary interventions focused on low-SES populations have found a measure of success. For example, a vocabulary intervention with kindergarten and first grade students from a low-SES school found that when sophisticated words were introduced during book reading and discussed afterward, children learned the vocabulary words more than those words not discussed after (Beck and McKeown 2007). Moreover, children learned better with six rather than three days of working with the sophisticated words. Another study with kindergarten students from a low-SES area found that teaching vocabulary words embedded in a story resulted in longer lasting vocabulary knowledge than incidental vocabulary learning (Coyne et al. 2009). However, teaching vocabulary using an "extended" strategy of spreading the teaching across several days resulting in a deeper understanding of the vocabulary words compared to an embedded strategy. In general, other factors relating to vocabulary interventions that have been found to have larger effects on children include having a teacher or researcher implement the intervention and using proximal, author created interventions rather than distal, standardized interventions (Marulis and Neuman 2013). Additionally, low SES was associated with smaller effect sizes for vocabulary interventions.

The current study adds to the literature reviewed by Marulis and Neuman (2010, 2013) by investigating a teacher-implemented language-focused intervention on curriculum-based assessments closely aligned to the intervention, as well as a standardized language comprehension measure, and which featured both explicit and implicit instruction. We targeted several of the intervention components previously discussed which have generally been found to relate to low (i.e., working with low-SES students, using a distal measure of vocabulary) and high effect sizes (i.e., also using a proximal measure of vocabulary), in an effort to further explore the discrepancy between effect sizes for the different types of measures and components of vocabulary interventions. Moreover, we also delve deeper into the implementation schedule than just frequency or intensity of teaching by testing two variations of the intervention. As noted above, Coyne et al. (2009) found different advantages of using a broad/embedded teaching style compared to a deep/extended strategy. Here, we piece apart these components, use both proximal and distal measures, and focus on a low-SES population greatly in need of vocabulary support.

An important distinction of the intervention examined here and those evaluated by Marulis and Neuman is that the present experimental intervention focused not only on vocabulary but also gains in children's text-structure knowledge, comprehension monitoring, and general language comprehension skills. Although some studies have found successful explicit teaching strategies for improving text-structure knowledge and comprehension, these studies have primarily focused on 7- to 8-year-old children (Williams et al. 2005; Williams et al. 2009). We intend to build upon these findings by working with younger children. Specifically, in the present study we report results of a year-long pilot study designed to examine impacts on children's oral language skills when their pre-K teachers implemented an experimental curriculum supplement, *Let's Know!*. *Let's Know!* is intended to be embedded within the typical language-arts/reading curriculum and provide enhanced opportunities for children to develop their language skills. Development of the supplement, which was the major task of a federally funded research consortium, is detailed extensively under separate cover (Language and Research Research Consortium, in press), thus we only highlight features of its development here. *Let's Know!* was developed and revised over a two-year iterative research process in which the major goal was to ensure that teachers could use the supplement with fidelity.

Each component of the intervention, such as the organization of lessons and the use of specific materials, was studied over the course of several design studies employing various methodologies (e.g., systematic observations, interviews, and focus groups) to ensure that it could be implemented as intended. When teachers' fidelity to any component was low or poor, it was revised and retested. Consequently, the final draft of the supplement was one that teachers could implement with fidelity, including following the lessons as intended, enacting the scope and sequence, and using specialized materials designed for the intervention (e.g., graphic organizers). The research presented here is the first test of the potential impacts of teachers' implementation of *Let's Know!* on children's language skills, specifically on those language skills that contribute to enhanced listening comprehension and, theoretically, reading comprehension.

To this point, *Let's Know!* was designed to provide pre-K teachers an instructional tool to explicitly improve children's lower- and higher-level language skills and overall language comprehension. Although not a focus of this study, there are also versions of *Let's Know!* for kindergarten through third grade students as well as a pre-K bilingual version. The focus of the supplement on improving children's language skills is grounded in the Simple View of Reading, which proposes reading comprehension to be the multiplicative function of decoding and language comprehension (Gough and Tunmer 1986). Both theory and research demonstrate that among skilled readers, one's skills in reading comprehension approximate one's language comprehension (Perfetti 2007). Among the most critical determinants of language comprehension and in turn, reading comprehension, are an individual's language skills, transcending component skills that can be characterized as *lower-* (i.e., automatic) and *higher-level* (i.e., integrative) (Catts et al. 2006).

Lower-level language skills influential to language comprehension include grammar (i.e., syntax and morphology) and vocabulary (Verhoeven and Van Leeuwe 2008), which together represent automatic processes that directly support one's ability to comprehend when they hear (i.e., language comprehension) and read (i.e., reading comprehension) (Perfetti 2007, p. 358). Higher-level language skills, on the other hand, represent integrative processes that allow one to infer, to monitor and correct one's comprehension, and to organize information coherently. Higher-level language skills particularly influential to skilled comprehension include inferencing, comprehension monitoring, and text-structure knowledge. Inferencing refers to one's ability to fill in missing information to arrive at a coherent, integrated representation of discourse heard or read; for instance, children often must infer the goals or motives of characters in stories (Lynch and van den Broek 2007). Comprehension monitoring refers to the ability to reflect on one's own comprehension and, in instances when comprehension is compromised (e.g., information read or heard is inconsistent), to seek to repair it (Wagoner 1983). Text-structure knowledge refers to one's knowledge about how texts are organized and includes one's ability to use critical information contained in texts to ascertain the type of text being read or heard, such as key words that signal cause-effect, compare-contrast, and sequences (Cain et al. 2004). These higher-level language skills are collectively referred to as "higher-level meaning construction skills" and "higher-level factors in comprehension" (respectively, Cain et al. 2004; Perfetti 2007) and, along with lower-level language skills (e.g., vocabulary, grammar), represent the scope of language-focused instruction addressed in *Let's Know!*, based on the hypothesis that promoting these component skills will lead to improvements in overall language comprehension in the short-term and reading comprehension in the long-term, although in this study we only report language skills upon completion of the intervention. In the present work, we

examine impacts of *Let's Know!* implementation by pre-K teachers on a subset of these lower- and higher-level language skills (viz., vocabulary, comprehension monitoring, text-structure knowledge), representing desired proximal outcomes, as well as general language comprehension, representing the desired distal outcome.

Although a number of recent studies have examined the effects of language-focused interventions within pre-K settings, these have largely if not entirely focused on improving children's lower-level language skills, such as grammar and vocabulary (Assel et al. 2007; Jackson et al. 2006; Justice et al. 2008; Lonigan et al. 2013; Mashburn et al. 2010; Piasta et al. 2010; Powell et al. 2010). However, the importance of higher-level language skills to overall language comprehension and future reading comprehension suggests that these too should receive explicit attention in language-focused interventions. In fact, it may be that children's higher-level language skills serve as a critically important causal lever for enhancing children's overall language comprehension, as suggested in several recent studies involving children in the primary grades (Clarke et al. 2010; Williams 2005; Williams et al. 2004, 2005). Clarke and colleagues, for instance, tested the effects of a language-focused intervention that featured activities designed to boost both lower- (e.g., vocabulary) and higher-level skills (e.g., text-structure knowledge, inferencing) for 8- and 9-year-old children with poor language and reading comprehension. Compared to more traditional forms of reading instruction (e.g., strategy training) and no instruction (the business-as-usual condition), those who received the language-focused intervention had improved language skills and reading comprehension 1 year post-intervention.

The purpose of this study was to examine the impacts of *Let's Know!* on the language skills of pre-K children. This work makes an incremental and unique contribution to our understanding of the effects of language-focused interventions in pre-K settings in that it examines impacts on both lower- and higher-level language skills as well as overall language comprehension. Although some work has shown that children's language skills, such as vocabulary and grammar, can be improved through targeted interventions delivered in pre-K settings (e.g., Penno et al. 2002; Pollard-Durodola et al. 2011; Wasik and Bond 2001), studies have seldom included general measures of language comprehension as outcome measures, nor have they included measures of children's higher-level language skills, such as comprehension monitoring and text-structure knowledge. This work helps to determine whether such skills can be improved through classroom-based interventions. To this end, this study addressed two research questions. First, to what extent does pre-K teachers' implementation of *Let's Know!* have positive impacts on children's lower- and higher-level language skills, specifically vocabulary, comprehension monitoring, and text-structure knowledge, compared to typical classroom practices? We hypothesized that children who were exposed to *Let's Know!* would significantly outperform children receiving typical classroom practices on measures of these skills post-intervention. Second, to what extent does pre-K teachers' implementation of *Let's Know!* impact children's general language comprehension, as compared to typical classroom practices? We hypothesized that children exposed to *Let's Know!* would significantly outperform children receiving typical classroom practices on a general measure of language comprehension post-intervention. Should these hypotheses be confirmed, the results of this study can benefit the field substantially by identifying an efficacious avenue for improving young children's lower- and higher-level language skills as well as general language comprehension within the preschool classroom context.

Methods

Participants

Eleven pre-K teachers in two states and a subset of children in their classrooms served as participants in this study. Participants were recruited prior to the 2012–2013 school year and received incentives in the form of checks or gift cards to teachers for participating. All of the teachers were lead teachers in publicly funded pre-K classrooms, all of which targeted enrollment towards children from low-socioeconomic status (SES) backgrounds. Teachers self-selected to enroll in the study following participation in information sessions providing details of the project. Twelve teachers initially enrolled in the study, but one subsequently dropped out after random assignment. Table 1 provides details regarding the gender, race, educational background, and teaching experience for the remaining teachers. As can be seen, the 11 teachers were all female, were generally well-educated (i.e., all had at least a Bachelor's degree), and were largely Caucasian. Informed consent was collected for all participants and Institutional Review Board approval was obtained. Authors report no conflict of interest.

In each classroom, up to five children were randomly selected to participate in ongoing assessments designed to measure intervention impacts. To identify this subset of children, caregivers of all children in each classroom were given a study brochure and informed-consent agreement in the fall of the academic year. Eligibility criteria included that the child must be proficient in English, have no severe or profound disabilities, attend class at least 3 days a week, and be older than 3 years and 9 months of age. From the consents received and deemed eligible, up to five children were randomly selected from each classroom or, in cases in which only five consents were received, all children were

Table 1 Descriptive information for participating teachers (n = 11)

Variable	*Let's Know!*					
	BAU		Broad		Deep	
	N	%	N	%	N	%
Education level						
BA	3	75	1	33	1	25
1+ year beyond BA	0	0	0	0	2	50
Master's	1	25	2	67	1	25
Gender						
Female	4	100	3	100	4	100
Race						
African American	0	0	0	0	0	0
American Indian	1	25	0	0	0	0
White/Caucasian	3	75	3	100	4	100
Years of experience						
1	2	50	0	0	0	0
2	0	0	0	0	0	0
3–4	0	0	0	0	1	25
5–10	0	0	0	0	2	50
11+	2	50	3	100	1	25

Years of experience refers to years teaching at the pre-kindergarten/preschool level

selected. In total, 49 children were included (25 males, 16 females, 8 unreported). Their mean age in the fall of the year was 53 months ($SD = 3.79$, range 45.21–59.6). In terms of race, 57 % of the children were White/Caucasian, 12 % were Black/African-American, 14 % were Asian, and 17 % were other ethnicities or the information was unreported. Data about disabilities were missing for nine children. Of the remaining 40 children, 12.5 % had identified disabilities and 8 % had difficulties in sensory or cognitive functioning, based on parental report. All of the children were from low-SES backgrounds, based on the targeted enrollment practices of participating centers. Accordingly, the parent-reported highest level of maternal education for the participating children was relatively low, with only 29 % of children's mothers having a bachelor's degree or higher. Data were missing for 11 parents.

Assignment to Study Conditions

In this study, teachers were assigned to implement one of two versions of *Let's Know!* (see "Methods and Materials"), which differed in the breadth of language skills targeted within the supplement or a control business-as-usual (BAU) condition. In the Broad Version, all five component language skills referenced previously were targeted (i.e., grammar, vocabulary, inferencing, comprehension monitoring, and text-structure knowledge), whereas in the Deep version only three component language skills were targeted (i.e., vocabulary, inferencing, and comprehension monitoring). The teacher who left the study was in the Broad condition, thus the final number of teachers was as follows: Broad, $n = 3$; Deep, $n = 4$; and BAU, $n = 4$. Condition assignment was not wholly random, as several teachers had previously participated in the design research developing early drafts of the curriculum. These teachers were automatically assigned to implement the experimental curriculum, although assignment to the Broad versus Deep versions was random. For the remaining teachers, random assignment to one of the three conditions was used. Children's condition assignment was based on their teachers' assigned condition. Final numbers of children per condition were as follows: Broad, $n = 15$; Deep, $n = 18$; and BAU, $n = 16$.

Methods and Materials

The primary methods of this study were twofold: (a) implementation of assigned study conditions by pre-K teachers, and (b) administration of assessments to children.

Implementation of Assigned Study Conditions

The pre-K teachers assigned to the two experimental conditions implemented three units of *Let's Know!* for 21 weeks of the academic year. Note that the final draft of the curricular supplement involves four units; however, this pilot study involved implementation of only three units as the fourth unit was not yet complete. Over the same period, BAU teachers implemented their typical classroom practices, while completing study-related activities designed to reduce Hawthorne effects (e.g., receipt of study incentives, provision of classroom materials, and provision of "neutral" professional development).

Let's Know! Implementation

Irrespective of version, teachers' implementation of *Let's Know!* features 120 min of systematic and explicit language-focused instruction each week. Instruction is organized into four 30-min whole-class lessons, which are arranged into three seven-week units. The units are thematically organized to address a specific topic (Unit 1, Animals; Unit 2, Fiction; Unit 3, Earth Materials), and each focuses on a specific type of text-structure (Unit 1, Compare-Contrast; Unit 2, Sequences and Cycles; Unit 3, Description). Teachers received a manual for each unit in its entirety and any materials needed for implementation (e.g., trade storybooks, manipulatives), which are described below.

To implement a *Let's Know!* unit, teachers follow semi-scripted lessons which provide specific language-focused objectives targeted within a given lesson, a structured sequence of activities to be followed for targeting these objectives, and sample scripts for teachers to follow. See Appendix 1 for a sample Words to Know lesson plan. Each unit comprises different types of lessons that target specific language skills: Text Mapping lessons target skills specific to text-structure knowledge and grammar, Words to Know lessons target skills specific to vocabulary development, and Integration lessons target skills specific to inferencing and comprehension monitoring. The Words to Know lessons involve providing specific definitions of new words as well as activities designed to build a deeper understanding of the new words. Text Mapping and Integration lessons focus on developing more general understandings of language, taught less explicitly than the vocabulary words in the Words to Know lessons. Two additional lesson types provide children with opportunities to participate in whole-class read-alouds with their teacher (i.e., Read to Me) and to explore books on their own (i.e., Read to Know).

The two versions of *Let's Know!* differ in relation to the types of lessons implemented. As shown in Table 2, the Broad version features all five lesson types organized into a seven-week sequence of instruction (see Appendix 2 for full schedule). The Deep version is also seven-weeks, however, the distinguishing feature of the Deep version is that there are fewer lesson types occurring in each unit but also increased opportunities for children to practice certain skills. The development of the Deep version (which is derived from the Broad version) was a result of teacher input during the curriculum design studies. Specifically, it addresses some teachers' suggestions that the intervention would be more effective if students had opportunities to practice skills specific to vocabulary, inferencing, and text-structure knowledge. It features three lesson types, omitting the Text Mapping and Read to Know lessons. In the Deep version, the Words to Know and the Integration lessons

Table 2 Lesson types in *Let's Know!*

Lesson type	Skills targeted	Version	
		Broad	*Deep*
Words to know	Vocabulary	X	X
Integration	Inferencing, comprehension monitoring	X	X
Text mapping	Text-structure knowledge, grammar	X	
Read to know	Motivation, background knowledge	X	
Read to me	Motivation, background knowledge	X	X

are expanded upon to provide increased opportunities to develop vocabulary (i.e., Words to Know), inferencing, and comprehension monitoring (i.e., Integration) skills. These expanded lessons (Words to Know Practice, Integration Practice) are similar to the original Words to Know or Integration lessons.

To support teachers' implementation of both the Broad and Deep versions of *Let's Know!,* a number of strategies were used. First, researchers met individually with each participating teacher prior to the start of the year to go over the manual of lesson plans, describe each of the lesson types, and to orient them to professional development (PD) modules that they would watch online. The manual contained all lessons and their implementation schedules, materials for each lesson, an overview of teaching strategies specific to each lesson type, and other necessary study materials (e.g., consent forms, contact information, list of participants). In addition, the PD modules (of which there were 3–8 depending on condition) provided a more in-depth examination of each of the lesson types to be used; these included videos of teachers implementing the lesson types and a moderator describing characteristics of effective lesson implementations. *Let's Know!* teachers completed the modules, which took approximately 6 h, prior to implementing the first lesson. After viewing each module, teachers completed an online survey indicating their comfort level of the given topic covered in the module. The surveys were used to monitor completion of the PD by each teacher. As a follow-up to the online training, research staff met individually with each teacher 2 weeks into implementation of the first unit. In this 30–60 min session, the staff member used information from teachers' PD surveys to identify any possible area in which they might need assistance or additional training (e.g., implementing a certain type of lesson).

Implementation Fidelity

Implementation fidelity for the *Let's Know!* teachers was monitored using classroom observations of an entire *Let's Know!* lesson, conducted within each classroom twice per unit. It is important to note that the development of *Let's Know!,* which occurred over a two-year period of iterative design studies, emphasized development of an intervention that could be used by teachers with fidelity. Thus, examination of fidelity in this pilot study largely focused on confirming high levels of fidelity, rather than seeking to explore differences in fidelity among teachers. In the present study, select lessons were coded for fidelity using a Fidelity Observation Checklist (FOC), developed for this study, which recorded teachers' implementation of the various components of each lesson. Based on live observations of 68 lessons in the Broad and 64 lessons in the Deep version, fidelity averaged 85 % across lessons.

Measures

The measures of relevance to this study are twofold: (a) proximal measures of lower- and higher-level language skills, and (b) distal measure of language comprehension.

Proximal Measures of Language Skills

A curriculum-based measure (CBM) was given by teachers blind to the other conditions and audio-recorded during week six of each seven-week unit in both versions to examine children's skills specific to vocabulary, comprehension monitoring, and text-structure

knowledge. Children in the BAU condition also completed these assessments to provide a counterfactual. We refer to this as a proximal measure of intervention impacts, as the items of the CBM are closely aligned to what is taught within the *Let's Know!* lessons. The vocabulary items required children to provide definitions for eight words targeted during the unit's lessons. An example question is: "Tell me what different means." Each definition was scored as correct (2 points), partially correct (1 point), or incorrect (0 points); thus, 16 points were possible.

The comprehension monitoring items required children to listen to a passage, identify an inconsistency in the passage, and then identify a strategy to correct the inconsistency. For example, the examiner would start reading from the book "Homes of Living Things" and purposely replace the word "deer" with the word "tiger" in a passage. After this replacement, the examiner would pause to allow the child to spontaneously identify the inconsistent item; if the child did not, he was prompted to do so. The child received 2 points for spontaneous identification of the inconsistency, 1 point for prompted identification, and 0 points if the inconsistency was not identified. Then, the examiner asked "What kind of fix-up strategy could I use to make sure I'm reading the correct words?" The child received one point for identification of a "fix-up" strategy (e.g., re-read the passage) and 0 points for an incorrect response. Two passages were administered, and three points were possible for each, resulting in a possible total of 6 points.

The text-structure knowledge items, of which there were two, involved presenting children with two short passages. For example, one passage pertained to mice and deer, describing ways in which they are alike and different. After listening to each passage, children identified the main idea from three options (scored as 1 = correct, 0 = incorrect). In this case the main idea was that mice and deer are alike and different. Next, children chose the most appropriate title from three options (scored as 1 = correct, 0 = incorrect). The appropriate title for the example passage would be Mice and Deer. Other options included Animal Food and Animal Size. In total, four points were possible. Note that each unit's CBM was uniquely constructed to examine children's skills specific to the content of a given unit; for instance, vocabulary items on the CBM following Unit 1 (Animals) examined children's knowledge of words targeted in that unit (e.g., shelter, habitat, different, alike). Although the tasks used to assess the three language skills were similar, the content varied. For the present purposes, we analyzed children's scores on the CBMs implemented after Unit 1 (week 6 of the intervention) and Unit 3 (week 20 of the intervention), with the latter implemented about 2–3 weeks prior to post-testing on the general measure of language comprehension. The Unit 2 CBM is not analyzed here due to highly different content material compared to Units 1 and 3, making comparisons between the three units ineffective. Specifically, Unit 2 covered fictional stories whereas Units 1 and 3 covered Animals and Earth Materials, both scientific in nature.

Distal Measure of Language Comprehension

The language comprehension measure used at pre- and post-test, referred to as the *Listening Comprehension Measure* (LCM), was developed as part of the larger consortium's research activities and administered by trained researchers. The LCM, adapted from the *Quantitative Reading Inventory-5* (Leslie and Caldwell 2006), provides an evaluation of children's language (rather than reading) comprehension. The LCM was collected at pre- and post-test in participating classrooms, in the fall of the year prior to the implementation of *Let's Know!*, and in the spring of the year, following implementation of the third unit. In general, about 22 weeks of instruction spanned pre- to post-test. The measure used is

considered distal to the intervention, as it represents a general measure of language comprehension and does not examine the specific component language skills targeted in the intervention (e.g., vocabulary skills, text-structure knowledge). Children listened to each of two passages told orally by an examiner (one narrative, one expository), then they were asked to answer six comprehension questions for the first story and four for the second. Students also completed a retelling of each story, but the retellings were not analyzed for this study. The overall raw score from the comprehension questions is used to represent overall performance. Scores on the LCM can range from 0 to 10. The validity of the LCM was examined in a consortium-administered longitudinal study involving 416 pre-K students, who were given the LCM and the *Test of Narrative Language* (TNL; Gillam and Pearson 2004); the correlation between the LCM and TNL was high (0.762).

Data Analysis

Analyses to test the impact of *Let's Know!* required consideration of the level of measure for each outcome, limitations due to sample size, and adjustments for the nested nature of the data. This study was based on feasibility to conduct a pilot study, and thus did not conduct a power analysis. Language comprehension (measured by LCM), the distal measure of language skill, was approximately normally distributed, but responses to the three measures of proximal language skill (vocabulary, comprehension monitoring, and text structure) on the CBMs did not form continuous scales. Vocabulary was assessed as a count of the number of correct responses on definitions of eight words, allowing for partial corrections; data from the comprehension monitoring assessment was ordinal and represented the degree of comprehension and recognition of inconsistencies, for which a larger value indicated better comprehension monitoring; and responses regarding text-structure were measured as counts of the number of pieces of text information correctly identified out of four, total. Consequently, we used a combination of generalized linear modeling approaches, including omnibus and contrast tests, confidence intervals, and effect size estimates to assess intervention group differences.

Due to concerns regarding small sample sizes for the non-normal outcomes (Newson 2001; UCLA: Statistical Consulting Group 2014; Zhu and Lakkis 2014), coupled with only partial randomization of teachers to intervention groups, we adjusted for potential residual correlation among outcomes for children with the same teacher using generalized estimating equations (GEE) and robust standard errors. GEE analyses are one of the most commonly used approaches for longitudinal and clustered data to adjust the standard errors in the model for residual correlation (Hilbe 2011). GEE coefficients are interpreted as marginal effects; that is, they are averaged over the distribution of random effects for teachers and they can be used to reproduce group means (or counts), as we show below. When inferences about treatment group differences are desired, rather than inferences about individual teacher-specific effects, these marginal or population-averaged coefficients are particularly useful (Moerbeek et al. 2003). In addition, the clustering of children within teachers is appropriately accounted for in GEE analyses, even if the correlational structure is mis-specified (Moerbeek et al. 2003). Thus, we take the GEE approach in these analyses, since our focus in this pilot study is on the extent to which *Let's Know!* affects proximal and distal child language outcomes, and not on the distribution of teacher-specific effects.

Particularly for the negative binomial model, small sample sizes can be problematic for estimation of parameters and their standard errors, and thus for statistical tests and their interpretation (Aban et al. 2008; UCLA: Statistical Consulting Group 2014). In general, the

impact of small samples also affects the ability to reliably detect differences in means or average counts between three or more intervention groups, which requires larger sample sizes for well-powered comparisons relative to a two-group design. Thus, we approached our assessment of CBM differences between the BAU, Deep, and Broad versions using two strategies: (1) statistical significance testing based on $\alpha = 0.05$ coupled with reporting of effect sizes and their interpretation; and (2) interpretation of substantive effect size calculations for effects under a more liberal $p < 0.10$ criteria (we note that all p-values for interpreted effects in the results reported below were <0.08). For small-samples research including pilot studies, Kramer and Rosenthal (1999) emphasize the importance of effect sizes over attainment of a discrete non-significant/significant p value (such as $\alpha = 0.05$); we feel this approach is informative here. Readers are cautioned about strict interpretation of p-values alone, and we note that the confirmation of the practical importance of our findings through replication is the goal of future follow-up randomized trials. Due to sample size limitations, treatment group was the only predictor in our models and no other covariates were included. We used dummy codes with BAU as the referent group, and we report and interpret contrasts between the Deep and Broad versions of the curriculum as well as effect size estimates for all regression parameters. In the results section below we provide additional specific analysis details for each outcome. SAS 9.4 was used for all analyses, and our GEE models were fit using SAS PROC GENMOD.[1]

Results

Here we analyze the CBMs to investigate our first hypothesis: that children who were exposed to *Let's Know!* would significantly outperform children receiving typical classroom practices on measures of these skills post-intervention. Next, we analyze results from the LCM to investigate the second hypothesis: that children exposed to *Let's Know!* would significantly outperform children receiving typical classroom practices on a general measure of language comprehension post-intervention. We begin by presenting the descriptive statistics for all measures and testing for differences between the groups of children in the three conditions.

Preliminary Analyses

Table 3 contains descriptive statistics for the three proximal CBM assessments and the pre- and post-test LCM scores. Frequency distributions for these variables were visually analyzed. Preliminary analyses tested initial equivalence among the three conditions on important teacher and child variables. Fisher's Exact Tests indicated no differences among conditions in terms of teachers' highest degree earned, years of preschool teaching experience, or certification to teach preschool (all p values >0.150). With respect to children, no differences were found in terms of age, $F(2, 46) = 0.771$, $p = 0.468$, gender, χ^2 $(2, N = 41) = 0.135$, $p = 0.935$, minority status, χ^2 $(2, N = 40) = 4.433$, $p = 0.109$, maternal education level, $F(2, 35) = 0.867$, $p = 0.429$, or LCM pre-test scores, $F(2, 46) = 0.745$, $p = 0.481$.

[1] Although the work is a collaborative effort, a member of the steering committee will take responsibility for the data and the accuracy of the data analysis.

Table 3 Descriptive statistics for proximal and distal measures

	Vocabulary				Comprehension monitoring				Text-structure knowledge			
	n	*M*	*SD*	*Md*	*n*	*M*	*SD*	*Md*	*n*	*M*	*SD*	*Md*
Proximal measures												
Unit 1 (week 6)												
BAU	16	1.6	2.0	1.0	16	0.4	0.8	0.0	16	1.0	0.7	1.0
Let's Know! Deep	18	6.3	4.2	5.5	18	1.6	1.6	2.0	18	0.9	0.7	1.0
Let's Know! Broad	15	5.3	2.2	6.0	15	0.9	1.3	0.0	15	0.8	0.8	1.0
Unit 3 (week 20)												
BAU	15	1.7	1.8	1.0	16	0.3	0.6	0.0	16	0.9	0.7	1.0
Let's Know! Deep	17	5.5	3.6	5.0	17	0.8	1.3	0.0	17	0.7	0.6	0.0
Let's Know! Broad	12	4.5	3.2	6.0	12	1.1	0.9	1.0	12	0.4	0.5	1.0

	LCM pre-test			LCM post-test		
	n	*M*	*SD*	*n*	*M*	*SD*
Distal measure						
BAU	16	4.3	2.4	15	4.9	2.3
Let's Know! Deep	18	3.8	2.0	17	6.2	2.1
Let's Know! Broad	15	3.3	2.4	12	4.7	3.1

LCM listening comprehension measure

Let's Know! Impacts: Proximal Measures of Language Skills

The first question addressed in this study concerned the extent to which Pre-K teachers' implementation of *Let's Know!*, which included the Broad and Deep versions, had positive impacts on children's lower- and higher-level language skills. The primary outcomes of interest were children's scores on the CBMs administered in week 6 (near the end of Unit 1) and week 20 (near the end of Unit 3), which included items addressing vocabulary, comprehension monitoring, and text-structure knowledge. Table 3 contains the CBM scores for children in the three conditions. Note that for nearly all indices, the pattern of results showed highest scores for children whose teachers implemented the Deep version of *Let's Know!*, followed by children whose teachers implemented the Broad version and then those whose teachers employed their normal classroom practices (BAU condition).

Vocabulary

Descriptive statistics and histograms indicated no extreme scores or outliers, but non-normality and positive skew were observed for both Unit 1 ($M = 4.469$, $Var = 13.213$, Skewness $= 0.736$) and Unit 3 ($M = 3.909$, $Var = 11.433$, Skewness $= 1.118$). The shape of the vocabulary distribution was characteristic of discrete count data for which a Poisson regression or other count model is often applied. For the vocabulary data the variance was larger than the mean at both time points, suggesting overdispersion; potential sources of overdispersion in count outcomes include small within-group sample sizes, outliers, or clustering in the data (Hilbe 2011; Hox 2010; Raudenbush and Bryk 2002).

Counts with overdispersion are best modeled using a negative binomial distribution rather than Poisson (Cameron and Trivedi 2013; Coxe et al. 2009; Hilbe 2011; Long 1997). Parameter estimates for the negative binomial model can be exponentiated and interpreted as expected counts (for the intercept) and for each the predictor represents the change in expected counts per unit increase, all else held constant (Long 1997). Using dummy codes for the three instantiation groups, differences in expected vocabulary counts between BAU and the Deep version, and BAU and the Broad version, were directly estimated; we also used defined contrasts to detect differences between the Deep and Broad versions.

The sphere of inference for this analysis was limited to the specific teachers included in the study, which was appropriate given that teachers volunteered for the pilot study, and some teachers had previously contributed to earlier work regarding the curriculum development; thus random selection and random assignment was not pure. In Table 4 we report regression coefficients, standard errors, and effect sizes (rate ratios) for the GEE analyses. Results show that both the Deep and Broad versions of *Let's Know!* had significantly greater expected counts on the vocabulary assessment compared to the BAU comparison, for both unit tests. For Unit 1, the estimated count of correct vocabulary words in the comparison group was exp(0.5089) = 1.663, which was not statistically different from zero ($p = 0.1813$). Note that this estimated count was similar to the mean count in the BAU condition (Table 4, M = 1.6 for BAU). Relative to children in the BAU condition, children of teachers in the *Let's Kno*w! Deep version correctly identified 3.8 times more vocabulary words (exp(1.3360) = 3.804); this represents an increase of about 280 % (100 % × (exp(B) − 1). That is, the mean count for the Deep version can be estimated as 1.663 × 3.804 = 6.326, corresponding to the observed mean of 6.3 in Table 4. Children in the Broad version correctly identified 3.2 times more vocabulary words (exp(1.1525) = 3.166) than children in the BAU group (about a 217 % increase). There was no significant difference in the correct response rates for vocabulary words between the Deep and Broad versions, $\chi^2(1) = 0.93$, $p = 0.3342$.

A similar pattern of results was observed for Unit 3, for which the estimated count of correct vocabulary words in the BAU group was exp(0.5239) = 1.689, which was not statistically different from zero ($p = 0.1689$). Relative to children in the BAU condition, children of teachers in the Deep version correctly identified 3.2 times more vocabulary words (exp(1.1739) = 3.235), representing an increase of 224 %; and children in the

Table 4 Negative binomial GEE regression predicting vocabulary by instantiation at Unit 1 and 3

Variable	*B*	*SE*	*p*	*Exp*(*B*)[a]	95 % CI *RR*	
					Lower	Upper
Unit 1						
Intercept	0.5089	0.3807	0.1813	1.663	0.789	3.508
Let's Know! Deep	1.3360	0.3983	0.0008	3.804	1.742	8.303
Let's Know! Broad	1.1525	0.4029	0.0042	3.166	1.437	6.974
Unit 3						
Intercept	0.5239	0.3746	0.1619	1.689	0.810	3.510
Let's Know! Deep	1.1739	0.3836	0.0022	3.235	1.525	6.860
Let's Know! Broad	0.9887	0.4718	0.0361	2.688	1.066	6.775

BAU is referent condition

[a] Exp(B) = RR = rate ratio

Broad version correctly identified 2.688 times more vocabulary words (exp(0.9887) = 2.688; 169 % increase) than children in the BAU group. Similar to Unit 1, there was no statistically significant difference in the correct response rates for vocabulary words between the Deep and Broad versions, $\chi^2(1) = 0.41$, $p = 0.5196$.

Comprehension Monitoring

Table 5 shows the distribution of responses for the comprehension monitoring (CM) task across both units and all three treatment groups. Given the ordinal nature of the data, we first fit a proportional odds regression model, predicting the cumulative probability of responses in higher CM categories relative to probability of scores in the lower CM response categories (O'Connell 2006). As with the vocabulary analyses, we used GEE estimation for robust standard errors to account for residual correlation within teachers, and dummy codes were used with BAU as the referent category. Results are provided in Table 6. We note that the coefficients $\alpha 4$ through $\alpha 1$ are used to define intercepts for each cumulative representation of the ordinal outcome, and focus our interpretation on the treatment conditions.

These analyses suggest a *slight* effect of responses being in the higher categories relative to the BAU condition for children in the Deep version in Unit 1 ($B = 1.6800$, $p = 0.0752$) and similarly for children in the Broad version for Unit 3 ($B = 1.8702$, $p = 0.0697$). Whereas neither effect reached conventional levels of statistical significance (i.e., $p \leq 0.05$), due to the small sample size we interpret differences substantively using odds ratios for effects based on a more liberal criteria of $\alpha < 0.08$. Thus, for Unit 1, children in the Deep version were 5.366 times as likely (exp(1.68) = 5.366) to be in higher categories, relative to the BAU children; and for Unit 3, children in the Broad version were 6.490 times as likely (exp(1.8703) = 6.490) to be in higher response categories, relative to the BAU group. These represent considerable improvements for children in these interventions. Contrasts comparing cumulative responses for the Deep and Broad versions were not statistically significant for either unit (Unit 1 $\chi^2(1) = 0.17$, $p = 0.6776$; Unit 3 $\chi^2(1) = 0.03$, $p = 0.8639$).

After inspection of the response frequencies in Table 7, and coupled with the large effect sizes observed in the ordinal regressions for the Deep version at Unit 1 and the Broad

Table 5 Comprehension monitoring and text structure frequency distributions across Units 1 and 3 for the three curricular groups

Response score	BAU	Deep	Broad	Total	BAU	Deep	Broad	Total
	Unit 1 CM				Unit 3 CM			
0	12	8	9	29	13	12	4	29
1	3	0	1	4	2	0	3	5
2	0	6	4	10	1	3	5	9
3	1	0	0	1	0	1	0	1
4	0	4	1	5	0	1	0	1
	Unit 1 TS				Unit 3 TS			
0	4	5	6	15	5	6	7	18
1	8	9	6	23	8	10	5	23
2	4	4	3	11	3	1	0	4

Table 6 GEE ordinal regression results for comprehension monitoring, Units 1 and 3

Variable	*B*	*SE*	*p*	*Exp(B)*[a]	95 % CI *RR*	
					Lower	Upper
Unit 1						
α_4	−3.1979	0.6640	<0.0001			
α_3	−2.9824	0.7727	0.0001			
α_2	−1.6154	0.5522	0.0034			
α_1	−1.2215	0.5653	0.0307			
Let's Know! Deep	1.6800	0.9433	0.0752	5.366	0.843	34.15
Let's Know! Broad	0.8041	0.7056	0.2544	2.235	0.561	8.91
Unit 3						
α_4	−4.8901	1.2252	<0.0001			
α_3	−4.1784	1.0346	<0.0001			
α_2	−2.1429	0.6421	0.0008			
α_1	−1.5300	0.7122	0.0317			
Let's Know! Deep	0.8931	0.9209	0.3321	2.443	0.402	14.850
Let's Know! Broad	1.8702	1.0310	0.0697	6.490	0.860	48.955

version at Unit 3, we decided to conduct an additional test, comparing the probability of responses in the two lowest CM categories (0 and 1) to the probability of responses in the higher categories (2, 3, or 4). This approach has been advocated as an alternative when few responses are beyond 0 or 1, as we have here (Cameron and Trivedi 2013). Thus, we used GEE through logistic regression and a binary response of being in the three higher categories or not; results are provided in Table 7. Although children in either *Let's Know!* versions tended to score in higher CM response categories at Unit 1, we found a statistically significant increase ($p < 0.05$) only for those in the *Deep* version compared to BAU children ($B = 2.93$, $p = 0.0226$, $OR = 18.75$); this pattern held for those children in the Broad version only under a more liberal significance level ($p < 0.08$) ($B = 2.015$, $p = 0.0709$, $OR = 7.50$). For Unit 3, children in either Deep or Broad tended to have higher CM responses relative to the BAU condition based on $p < 0.08$, but neither attained statistical significance at conventional levels (for Deep, $B = 1.83$, $p = 0.1199$, $OR = 6.23$; for Broad, $B = 2.37$, $p = 0.0747$, $OR = 10.70$).

Table 7 Logistic regression (GEE) predicting CM response categories 2, 3, or 4

Variable	*B*	*SE*	*p*	*Exp(B)*[a]	95 % CI *OR*	
					Lower	Upper
Unit 1						
Intercept	−2.7081	1.0022	0.0069			
Let's Know! Deep	2.9312	1.2858	0.0226	18.75	1.508	233.04
Let's Know! Broad	2.0149	1.1155	0.0709	7.50	0.84	66.77
Unit 3						
Intercept	−2.7081	1.0022	0.0069			
Let's Know! Deep	1.8326	1.1783	0.1199	6.23	0.621	62.929
Let's Know! Broad	2.3716	1.3305	0.0747	10.70	0.790	145.34

Text-Structure Knowledge

Similar to comprehension monitoring knowledge, responses to text-structure were ordinal (Table 5) and thus were modeled using a proportional odds regression analysis (O'Connell 2006) with GEE estimation and robust standard errors to account for residual clustering, and dummy coding of the curriculum groups. The probability of being in cumulatively higher categories, relative to being in lower categories, was assessed. There were no significant differences across the versions for either Unit 1 or Unit 3 (all $ps > 0.10$). Similar to the other CBM analyses, contrast comparisons indicated no significant differences between Deep and Broad for either Unit.

Let's Know! Impacts: General Language Comprehension

The second question addressed in this study concerned whether pre-K teachers' implementation of *Let's Know!* improved children's general language comprehension, based on the LCM. This was considered a distal outcome of the intervention, as general language comprehension was not directly targeted in the intervention; rather, *Let's Know!* is designed to improve component language skills. This research question was addressed via analysis of covariance using children's pre-test scores as a covariate in a regression predicting post-test scores on the LCM. LCM pre-test scores were grand-mean centered and treated as a fixed-effect covariate. As in the previous analyses, condition was entered into the analysis as a series of dummy codes representing the two *Let's Know!* conditions, and BAU served as the referent group. Also similar to the previous models, we used GEE and robust standard errors to account for residual correlation given children nested within teachers. For this continuous outcome, the proportion of variance between teachers for the post-test LCM scores was minimal; the intraclass correlation was less than 0.02.

The descriptive statistics for pre- and post-test scores on the LCM were presented earlier in Table 3. GEE results are provided in Table 8. After adjusting for pre-test scores on the LCM, children whose teachers implemented the Deep version had significantly greater post-test LCM scores as compared to children in the BAU condition, with a large effect size ($B = 1.963, p < 0.0001, d = 0.63$). However, this was not the case for children whose teachers implemented the Broad version; the effect size was small and the comparison was not significant ($B = 0.382$, $p = 0.4424$, $d = 0.12$). A contrast comparing the two *Let's Know!* versions found no significant difference in adjusted post-test LCM scores between children whose teachers implemented the Broad versus Deep versions.

Table 8 GEE analysis of covariance predicting post-test LCM from condition and pre-test LCM (grand-mean centered)

Variable	*B*	*SE*	*p*	*d*[b]	95 % CI (*B*)	
Intercept	4.3692	0.1897	<0.0001		3.9974	4.7410
Let's Know! Deep	1.9630	0.2795	<0.0001	0.63	1.4151	2.5108
Let's Know! Broad	0.3819	0.4971	0.4424	0.12	−0.5924	1.3561
Pre-test LCM[a]	0.6372	0.0980	<0.0001		0.4450	0.8294

[a] Covariate is grand-mean centered

[b] Uses *SD* (pre-test $LCM_{control}$) as conservative denominator for Cohen's *d*

Discussion

The *Let's Know!* curriculum supplement was developed over two years using an iterative process of testing and revising based on careful observations of implementation and teachers' feedback. Many language interventions focus primarily on lower-level language skills, such as vocabulary (Assel et al. 2007; Jackson et al. 2006; Justice et al. 2008; Lonigan et al. 2013; Mashburn et al. 2010; Piasta et al. 2010; Powell et al. 2010). Although these lower-level language skills have been linked to language and reading comprehension (Gough and Tunmer 1986), higher-level language skills, such as comprehension monitoring and text-structure, also play a crucial role in literacy development (Oakhill and Cain 2012; Williams 2005; Williams et al. 2004, 2005). *Let's Know!* aims to improve both lower- and higher-level language skills (vocabulary and comprehension monitoring/test-structure knowledge, respectively) as well as general language comprehension. This study explored the influence on pre-K children's oral language skills of two versions of a language intervention (*Let's Know!* Broad, *Let's Know!* Deep) relative to a BAU condition. Four main findings emerged: (1) both *Let's Know!* versions improved vocabulary relative to the BAU condition, (2) both *Let's Know!* versions appeared to have positive impacts on comprehension monitoring relative to the BAU condition, (3) neither *Let's Know!* version improved text-structure knowledge relative to the BAU condition, and (4) only *Let's Know!* Deep improved general language comprehension.

First, we measured the proximal influence of the language intervention on vocabulary, a low-level language skill, and comprehension monitoring and text-structure, high-level language skills. For Units 1 and 3, children in both the *Let's Know!* Deep and Broad conditions demonstrated more vocabulary knowledge than children in the BAU condition. Performance did not differ for children in the two *Let's Know!* conditions. This study adds to the mixed findings regarding the effectiveness of language interventions at improving oral language, specifically vocabulary. Although some studies have not found improvements in vocabulary as a result of a language intervention or curriculum (Powell et al. 2010), the results of this study align with the few studies demonstrating that language interventions or curriculums can improve vocabulary (Assel et al. 2007; Clarke et al. 2010). Moreover, we demonstrated that vocabulary improvements may be possible on a proximal vocabulary measure after only 6 weeks of intervention whereas previous work primarily reports vocabulary results after completion of a longer intervention (e.g., 20 weeks for Assel et al. 2007 and one school year for Clarke et al. 2010).

The second main finding was that there was an improvement in children's comprehension monitoring after Unit 1 for the Deep version and after Unit 3 for the Broad version, relative to children in the BAU group. Importantly, neither version reached a 0.05 significance level, despite the large effect sizes. With the logistic regression results comparing the lower scores with the higher scores, however, we see that performance in Unit 1 for the Deep version did reach <0.05 significance and the performance in the Unit 3 Broad version remained at a 0.08 significance level. Thus, we found a pattern of improvement for children in both intervention conditions, but these results should be interpreted cautiously due to the small sample size. Finding this benefit from the intervention is particularly interesting considering the small sample size and that prior research has found successful comprehension monitoring of oral or written text begins to develop between preschool and third grade, with several studies reporting little success for younger children within this age range (see Wagoner 1983 for review). Thus, although we found that pre-K children's scores improved with this language intervention, the scores may have improved more if the intervention was implemented with slightly older children.

Third, there was no difference in text-structure knowledge between children in the *Let's Know!* Deep, *Let's Know!* Broad, and BAU conditions. This was somewhat unexpected because of the intervention's focus on text-structure, specifically in the Broad version. Similar to comprehension monitoring development, successful understanding of text-structure is generally found for older children or a subset of younger children who have good verbal skills and good working memory, which speaks to the difficulty level of this skill (Cain et al. 2004). The different results for vocabulary and text-structure may be related to the structure of the Words to Know lessons, which involved providing both explicit definitions of new words and implicit connections between words. However, Text Mapping and Integration lessons were not able to provide similarly explicit definitions and information. Perhaps the less explicit instruction did not allow for children to fully develop their understanding of text-structure (and the same may be true for comprehension monitoring), which could account for the lower performance in the related abilities measured in the CBMs. Thus, the introduction of the *Let's Know!* curriculum supplement, in either the Deep or Broad form, improved children's vocabulary skills, a lower-level language skill, above that of attending a typical classroom. Implementation of *Let's Know!* improved comprehension monitoring abilities, a higher-level language skill, but neither version of the intervention improved text-structure knowledge.

Fourth, we examined the intervention's effect on language comprehension. Children whose teachers implemented the *Let's Know!* Deep curriculum supplement showed greater gains on the *Listening Comprehension Measure* relative to children with teachers in the BAU condition. No difference in gains was found between participants in the *Let's Know!* Broad condition compared to either *Let's Know!* Deep or BAU. Thus, our language intervention was successful in boosting children's language comprehension abilities compared to standard classroom activities. Specifically, the *Let's Know!* Deep version, which allowed children increased practice opportunities on a restricted number of lesson types, went beyond immediate language improvement to influence general language comprehension. This pattern of higher scores in the Deep version was also found for the proximal measures of vocabulary and one unit of comprehension monitoring. Similar advantages of a "deep" teaching method have been reported for other areas of education, specifically science education (Schwartz et al. 2009). In a large study exploring the relation between deep or broad science training in high school and performance in college science courses, Schwartz and colleagues found a general advantage for "deep" training in high school leading to success in college science courses. However, it is difficult to compare the results of a curriculum for pre-K students and high school students. It is also important to note that even the Broad version seems promising in that it resulted in improved performance relative to the pre-test and for vocabulary and comprehension monitoring. Further research may find that the Broad version of the program is also effective at increasing language comprehension, but it currently seems that the Deep version shows the most promise upon which we may build an even more successful language intervention. An alternative explanation of these results is that the vocabulary boost found throughout the intervention led to improvements in general language abilities, perhaps due to having a larger vocabulary and a better understanding of how to acquire new words. Unfortunately, it is not within the scope of this paper to explore that relationship more deeply.

Several limitations of this study warrant note. First, the teachers' assignment to conditions was not wholly randomized, potentially leading to teachers having varying levels of experience with the curricula, as a result we must be cautious in the interpretation of the findings. Random assignment of teachers would increase our confidence that the results reflect treatment condition and not other variables. Second, the sample size was modest.

Future examination of effects of this intervention on children's language skills is needed. Third, measures used to assess children's outcomes were experimental. Future studies should examine treatment effects on standardized and/or commonly used measures. Finally, this study focused on children with low-SES backgrounds. Research with children from high-SES backgrounds may find different, potentially stronger results.

To summarize, this study is an important contribution to the literature on pre-K children's language development because it demonstrates that it may be possible to improve the vocabulary and comprehension monitoring abilities of low-SES pre-K children after just 6 weeks of curriculum intervention and general language comprehension abilities after just 21 weeks. Moreover, this work suggests that with this language-focused curriculum, implementing fewer lesson types with more time for practice in each one (the Deep version) allows children to build general language comprehension skills better than if they had experienced a larger variety of lessons (the Broad version). These data from an "as treated" design will inform the development of a follow-up randomized trial study further testing the impact of the *Let's Know!* intervention. Taken together, the results of this study show both proximal and distal advantages of the *Let's Know!* curriculum supplement for pre-K children and can inform future language research and curriculum development.

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Compliance with Ethical Standards

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Conflict of interest LARRC has received research grants from the Institute of Education Sciences.

Statement of Human Rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Appendix 1

LET'S KNOW! PREK	ANIMALS COMPARE AND CONTRAST	WORDS TO KNOW LESSON 3

Show Me What you Know! Animals live in many different kinds of homes! We're going to be animal biologists reporting on how animal homes are alike and different!

Teaching Objective(s):

- Use the Words to Know in hands-on activities providing an example of a word's meaning

Teaching Technique(s):

- Rich Instruction

Lesson Materials You Provide:

- Stuffed animals, animal figures, or puppets to act out 'protect'
- Materials for tabbed books – scissors, ruler, stapler, paper
  - 1 tabbed book per student

Unit Materials Provided:

- Habitat pictures from Lesson 1
- Pictures to demonstrate **alike** and **different**
- Pictures to glue on a page for their tabbed word book - **habitat, alike, different, protect**
- Vocabulary picture cards (optional)

Lesson Text:

- Homes of Living Things by Bobbie Kalman

Talk Structure for We Do/You Do:

- Think-Pair-Share

Words to Know:

- **habitat** (noun): the area where an animal likes to live - H, A
- **alike** (adjective): two things that are like each other - O
- **different** (adjective): not the same or unlike - A
- **protect** (verb): to keep safe - H, A
- **shelter** (noun): something that provides cover or protection - H, A
- **survive** (verb): to stay alive - A
- **prairie** (noun): large area of flat grasslands - H, A
- **insect** (noun): bug with a head, thorax and abdomen and three pairs of legs – H

Lesson Texts:

- H = Homes of Living Things by Bobbie Kalman
- A = Animal Habitats by Michelle Kramer
- L = Loud and Quiet:. An Animals Opposites Book by Lisa Bullard
- O = other texts

Special instructions for this lesson:

- The **I DO/WE DO** parts are combined in this lesson to allow focusing on one word at a time for modeling by the teacher and guided practice with students
- In the text, Homes of Living Things, the four unit vocabulary words appear on the following pages: **habitat** – 6, 7, 8, 15, 16, & 17 **protect** – 4 & 11 **different** – 5
- In each of the four Words to Know lessons in the unit, the students will create pages for a tabbed book on Animal Homes Words to Know. In this lesson students will create a page illustrating one of the first four words. This can be done later at a center time or free choice. For help with creating a tabbed book, visit http://www.squidoo.com/tabbed-book

LESSON PLAN

SET	**Introduce the idea that there are lots of words that people use, and sometimes we don't know what these words mean. When we are reading a non-fiction or information book, there might be many new words about the book topic. We have to train our brains to listen for words we don't know, and then try to figure out what they mean.** **You could say:** "There are so many words that people use every day and we don't always know what they mean. In our new book Homes of Living Things, there are new words about animals and where they live. We have to be super animal biologists and train our brains to listen for these new words so we will be able to learn about animal homes and report to our friends lots of new and interesting information."
I DO / WE DO	**Follow the steps for Rich Instruction for four of the unit's Words to Know: habitat, protect, alike, and different.** • **Introduce the words while reading the text Homes of Living Things, studying the WRAP vocabulary pictures, reading another text, or using any other method** • **Follow the steps for rich instruction for each word** **For the word 'habitat' you could say:** (p. 15) "Our book says, 'Chimpanzees live in hot, rainy, forest **habitats.**' A **habitat** is the area where an animal likes to live. At the zoo they build special **habitats** for the **different** animals. I like to visit the African grasslands **habitat**. It has giraffes, water buffaloes, and large birds. Let's all say the word **habitat** together." **Display habitat pictures from Lesson 1 and ask students to name the type of habitat depicted.** **For the word 'protect' you could say:** (p. 11) "This says the rattlesnake's home is a cave. 'The cave **protects** the snake from the hot sun.' **Protect** means to keep safe. The sun in the desert can be very, very hot. Many animals, including people, need to be **protected** from the sun. My mom and dad cross the street with me so I will be **protected** from the cars. Let's all say the word **protect**." **Give students a turn to act out protect with a play animal and props.** **For the word 'alike' you could say:** (pp. 12 & 13) "The homes of these animals are **alike** because they are all homes made from holes in something. **'Alike'** means things that are like each other. My friend and I have bikes that look the same; they're **alike**. My grandpas both have white hair and look **alike**. Let's all say the word **alike**." **Show students 'alike' cards, and students say 'alike.'** **For the word 'different' you could say:** (p. 24) "These pictures show **different** animal homes. **Different** means not the same or unlike. My hair is a **different** color than my daughter's. My friend and I ride **different** buses to school. Let's all say the word **different**." **Students turn over two animal cards and say 'different.'**

YOU DO	**Students illustrate or glue a picture on a page to depict protect, habitat, alike or different for their tabbed Words to Know book.** **You could say:** "We are going to learn lots of new words while we study animal homes. Here is a Words to Know book for each of you. Today I want you to make a page with one of our new words. We can add to our books as we learn new words and use them to help us write our reports about how animal homes are **alike** and **different.**" **Ask students to share their page with a partner or the rest of the class.**
CLOSE	**Summarize the importance of learning to identify new words that occur around us and to learn more about these words. Explain how important it is to be able to identify words in books we read so we can learn more information about the world around us.** **You could say:** "Nice job learning four new words today. We are going to hear these words all through our unit on Animal Homes. It is really important to pay attention to words and what they mean. That helps us understand new information about animals and Animal Homes. Together let's practice using each of our new words in a sentence: • Some people **protect** elephants. • Drink water in a desert **habitat.** • The two birds' nests were **alike.** • The horses are two **different** colors."

Appendix 2

See Table 9.

Table 9 Lesson sequence within a *Let's Know!* unit: Broad and Deep versions

Week	Lesson	Broad version	Deep version
1	1	Hook	Hook
	2	Read to me	Read to me
	3	Words to know	Words to know
	4	CBM preview[a]	CBM preview
2	5	Text mapping	Words to know
	6	Words to know	Words to know practice
	7	Integration	Integration
	8	Read to know	Integration practice
3	9	Read to me	Read to me
	10	Text mapping	Integration
	11	Integration	Words to know practice
	12	Words to know	Words to know

Table 9 continued

Week	Lesson	Broad version	Deep version
4	13	Text mapping	Integration
	14	Integration	Integration practice
	15	Words to know	Words to know
	16	Read to know	Words to know practice
5	17	Read to me	Read to me
	18	Text mapping	Integration
	19	Integration	Integration practice
	20	Read to know	Words to know practice
6	21	Read to know	Integration practice
	–	CBMs	CBMs
7	22	Stretch and review	Stretch and review
	23	Stretch and review	Stretch and review
	24	Close	Close

[a] *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 (lesson 4, week 1); 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

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