**Impacts of the Let’s Know! Curriculum on the Language and Comprehension-Related Skills of Prekindergarten and Kindergarten Children**

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**Author Note**

This paper was prepared by a Task Force of the Language and Reading Research Consortium (LARRC) consisting of Shayne B. Piasta (Convener), Ann A. O’Connell, Mindy Bridges, Shelley Gray, Kate Cain, Meng-Ting Lo, and Menglin Xu. Meng-Ting Lo is now at National Yang Ming Chiao Tung University. LARRC project sites and investigators are as follows:

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Let’s Know! materials are available at <https://larrc.ehe.osu.edu/>.

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# Abstract

Although substantial research has established how to teach word reading, the research base for teaching skills related to language and reading comprehension is more limited. We report a multi-state experiment of a supplemental, whole-class language-focused curriculum delivered in prekindergarten and kindergarten classrooms that was designed to improve children’s language comprehension and thereby support later reading comprehension. We randomly assigned 69 prekindergarten classrooms (*n* = 361 children) and 56 kindergarten classrooms (*n* = 328 children) to receive language-focused intervention or to a control condition. Children in intervention conditions experienced one of two instantiations of Let’s Know! (Let’s Know! Broad or Let’s Know! Deep) as implemented by their classroom teachers. Both instantiations provide four 30-min lessons per week of targeted instruction on key lower- and higher-level language skills over 25 weeks; the instantiations differ in the amount of practice afforded to particular skills. We measured children’s comprehension-related skills (target vocabulary, comprehension monitoring, understanding narrative text and story grammar, understanding expository text) via curriculum-aligned measures during the academic year and their vocabulary and language comprehension at pretest and posttest. Multilevel analyses showed similar effects for both instantiations, with Let’s Know! positively impacting some of the immediate tests of curriculum-aligned skills (vocabulary, comprehension monitoring, understanding of expository text) and also the posttest vocabulary outcome, but not standardized language comprehension outcomes; impacts on curriculum-aligned skills did not mediate effects on language comprehension outcomes. Results have implications for the Let’s Know! theory of change as well as continued research on supporting children’s language and comprehension skills.

*Keywords*: oral language, comprehension, supplemental instruction, prekindergarten, kindergarten

# Educational Impact and Implications Statement

Despite improvements in word-level reading instruction, many children continue to struggle with reading comprehension. In this study, we tested a whole-class supplemental curriculum, Let’s Know!, designed to support prekindergarten and kindergarten children’s oral language and comprehension skills. We found that Let’s Know! improved children’s knowledge of vocabulary used in the curriculum and some comprehension-related skills but did not impact scores on standardized language comprehension measures. Results provide evidence that classroom instruction can improve some skills related to later comprehension; however, more work is necessary to develop and validate curricula that directly impact language and reading comprehension.

**Impact of the Let’s Know! Curriculum on the Language and Comprehension-Related Skills of Prekindergarten and Kindergarten Children**

In industrialized nations, reading achievement is associated with an individual’s educational attainment, employment opportunities and earnings, and health outcomes (World Literacy Foundation, 2015). This presents a challenge for the U.S., in which many children have limited reading proficiency and struggle to comprehend what they read (Douglas & Albro, 2014). The current study is predicated on evidence that language comprehension is a critical component of reading comprehension from the earliest stages of learning to read (Language and Reading Research Consortium, 2015), that early oral language skills provide a foundation for later reading comprehension success (Hjetland et al., 2020; Kendeou et al., 2009), and that early intervention is optimal (O'Connor et al., 2005). We report a multi-state experiment of a Tier 1, language-focused supplemental curriculum delivered in prekindergarten (PK) and kindergarten (K) classrooms. This whole-class curriculum was designed by the Language and Reading Research Consortium (LARRC) as part of the Reading for Understanding Initiative, funded by the Institute of Education Sciences of the U.S. Department of Education, to improve language and reading comprehension skills. The Reading for Understanding Initiative was a $120 million investment in research focused on improving reading comprehension in PK through Grade 12. The initiative responded to national concerns about reading achievement scores levelling off in the U.S. The National Academy of Education recently published a report synthesizing Reading for Understanding Initiative findings that is freely available on its website (Pearson et al., 2020).

## Targeting Early Language to Improve Comprehension

A wealth of studies, using both cross-sectional and longitudinal methodologies, has demonstrated the importance of oral language as the basis for reading comprehension (e.g., Dickinson et al., 2019; Hjetland et al., 2019; LARRC & Chiu, 2018; Metsala et al., 2021). This is consistent with the Simple View of Reading (Gough & Tunmer, 1986), which posits that skills related to language comprehension, as well as those related to word recognition, are an essential component of reading comprehension. In particular, vocabulary, grammar, and discourse-level skills (e.g., inference, narrative, comprehension monitoring) each make distinct contributions to early reading comprehension (Cain et al., 2004; LARRC & Logan, 2017). These skills are often weak in children demonstrating reading comprehension difficulties (Catts et al., 2006; Nation et al., 2004). Of note, longitudinal studies that have followed samples from PK or K demonstrate that the code-related precursors of word reading and the oral language precursors of reading comprehension follow separable trajectories (Hjetland et al., 2020; Kendeou et al., 2009) and that individual differences in PK language skills uniquely predict later reading comprehension through language comprehension (LARRC & Chiu, 2018; Lepola et al., 2016). As a result, oral language skills are seen as excellent candidates for interventions to remediate or prevent reading comprehension difficulties (Dickinson et al., 2010).

However, many studies intervening on specific oral language skills show limited impact on broader language skills (e.g., Haley et al., 2017). This may be due to the fact that language skills do not consist of a finite set (cf. letter names and sounds) and develop over a long period of time (Dickinson et al., 2010). In this respect, language skills are less easily malleable than code-related skills. In addition, we need to consider what is taught and how. Reading and language comprehension draw on a wide range of skills, both foundational lower-level language skills such as vocabulary and grammar, and also higher-level knowledge and skills such as text structure, inference making, and comprehension monitoring (Cain et al., 2004; Kim, 2016; Lepola et al., 2012; Strasser & Río, 2014). Effective interventions need to influence children’s processing of text for meaning (van den Broek et al., 2011); curricula and interventions that focus on just a single dimension, such as vocabulary, may be insufficient for developing the full range of knowledge and skills involved in constructing meaning from text, limiting the transfer of impacts to language and reading comprehension.

Research shows that intervention during the PK period can prepare young children for later instruction in both word reading and reading comprehension. There is a strong continuity in the development of phonological sensitivity and letter knowledge from PK and these abilities predict later word reading success (Lonigan et al., 2000). Building on this, PK and K interventions in phonemic awareness, letter knowledge, and phonics instruction have been shown to support the early acquisition of word reading skills (Ehri et al., 2001; National Early Literacy Panel, 2008).

There is also mounting evidence that early instruction can improve specific language skills (Lonigan et al., 2013; Marulis & Neuman, 2010; Silverman et al., 2020); however, results differ depending on whether effects are evaluated with curriculum-aligned assessments of targeted skills, outcome measures that are closely aligned to the target of instruction (referred to as secondary outcomes by Clarke et al., 2010), or primary (i.e., more distal) outcome measures, which are typically standardized assessments (Clarke et al., 2010). In a meta-analysis of 43 studies investigating language comprehension interventions in U.S. elementary schools, positive effects were found on “custom” (i.e., targeted or secondary outcome) measures of vocabulary, listening comprehension, and reading comprehension but not on standardized assessments (Silverman et al., 2020).

A number of studies have provided code-related and oral language interventions with the goal of improving reading outcomes. Bowyer-Crane et al. (2008), for example, randomly assigned 152 four-year-olds from 19 UK schools to a 20-week treatment program focused on either phonology plus reading or oral language. Children in the phonology plus reading condition showed an advantage over the oral language condition on letter knowledge, spelling, prose reading accuracy, and phonemic segmenting/blending/deletion at the end of the study and five months later, whereas children in the oral language condition showed an advantage on vocabulary and expressive grammar. Thomas et al. (2020) evaluated the impact of a 30-session interactive reading intervention on the emergent literacy skills of 285 children attending Belgian kindergartens, many of whom were from low socioeconomic and language-minority backgrounds. Post-intervention, children in the intervention condition (11 classes) scored significantly higher on vocabulary, morphosyntax, print awareness, letter knowledge, and phonological awareness measures than those in the control condition (8 classes). In contrast, Piasta et al. (2020) did not find positive impacts of another shared reading intervention, Read It Again!, on language and literacy skills relative to a control condition in which teachers read the same books without the intervention lessons. This study was conducted with 726 children enrolled in 109 U.S. early childhood special education classrooms. As a final, and notable, example, Fricke et al. (2013) studied an intervention focused exclusively on oral language. They randomly assigned 180 children from 15 UK nursery schools to a 30-week language intervention delivered by teaching staff or a waitlisted control condition. Intervention focused on vocabulary, narrative, active listening, and confident speaking. Children in the intervention condition scored significantly higher than those in the control condition on oral language and spoken narrative measures at the end of intervention and 6 months later, when they also scored significantly higher on a reading comprehension outcome.

In addition to these studies of direct intervention, there is evidence that specific features of classroom environments, such as teacher-talk, are related to concurrent and longitudinal language and literacy outcomes (Dickinson, 2011; Dickinson & Porche, 2011). High-quality programs include responsive teaching and classroom environments that offer a variety of learning opportunities (Pianta et al., 2002), implementation of empirically-based curricula (Jenkins et al., 2018), teaching that matches children’s developmental levels, and effective professional development aligned to desired child outcomes (Sheridan et al., 2009). The problem is that although professional development can improve teachers’ language and instructional practices (Brunsek et al., 2020; Sheridan et al., 2009), it is not readily available to many early childhood educators (Gomez et al., 2015) and changes in teachers’ language practices must be robust enough to affect child language outcomes (Dickinson, 2011).

In summary, research suggests that we have had greater success in the teaching of precursor skills necessary for later word reading than the language skills necessary for later reading comprehension. Despite some promising evidence for the latter, in general, researchers investigating the effects of early language interventions have not measured their impact on language or reading comprehension (cf. Fricke et al., 2013). Finally, teachers’ abilities to model high-quality oral language and to provide oral language practice for children is linked to better language development but it is difficult to achieve change in these practices. These findings suggest that Tier 1, classroom-based interventions need to address multiple language skills to support language comprehension and construction of meaning-based representations of texts necessary for reading comprehension. We adopted these principles in the whole-class curriculum that we developed.

**Let’s Know! Curriculum Development and Prior Research**

Our research team developed and piloted an evidence-based, language-focused supplemental curriculum, Let’s Know!, for use in PK and elementary-school (Grades K to 3) classrooms. Our theory of change was related to the Simple View of Reading. Early in the development process, we determined that our focus would be on providing classroom teachers with curricular materials that systematically taught lower- (vocabulary, grammar) and higher-level (text structure, inference making, comprehension monitoring) language skills; thus, we developed Let’s Know! to impact the language comprehension component of the Simple View of Reading. We hypothesized that positive changes in lower- and higher-level language skills would improve language comprehension, which would in turn improve reading comprehension.

The curriculum development process included nine phases completed over 3 years, described in detail in LARRC (2016). This systematic, evidence-based gold standard approach to curriculum development was based on Clements’ (2007) curriculum research framework. In essence, during the first three phases, we focused on content establishment, identifying learner goals, and making decisions regarding our pedagogical approach. In the fourth phase, we laid out the scope and sequence of learning with accompanying teaching activities. The final phases included iterative evaluations of the curriculum including marketing research, design studies, formative assessments, and summative evaluations.

The resultant Let’s Know! curriculum involved lessons structured into four units (three 7-week units plus one 4-week unit), with units organized thematically (Unit 1: Fiction, Unit 2: Animals, Unit 3: Earth Materials, Unit 4: Folktales) and by text structure (cycles and sequences, compare-contrast, description, cause-effect); Supplementary Material Table S.1 provides an overview. We developed two instantiations of the curriculum as detailed in LARRC (2016): Let’s Know! Broad and Let’s Know! Deep. The Broad instantiation included eight lesson types taught iteratively over 2-week periods. The units open with a *Hook* lesson, designed to pique children’s interest and provide an overview of unit content, and end with a *Close* lesson, designed to help children consolidate their learning across the unit. Within units, teachers and children progress through specific types of lessons to meet language-focused learning objectives. For Let’s Know! Broad, lessons include (a) *Read to Me*, designed to engage children with text and promote rich discussion, inferential language, and comprehension monitoring, (b) *Words to Know*, designed to teach unit vocabulary, (c) *Text Mapping*, designed to facilitate production and understanding of different text and grammatical structures, (d) *Integration*, designed to teach and practice retelling, inferencing, comprehension monitoring, and summarizing/finding the main idea for various text structures, (e) *Read to Know*, designed to promote engagement and interest through independent reading, (f) *Show Me What You Know*, during which teachers administer curriculum-aligned measures (CAMs) to monitor children’s progress and plan for Stretch and Review lessons, and (g) *Stretch and Review*, designed to provide teachers with opportunities to review key concepts or dive deeper into unit topics depending on class needs and interests.

In Let’s Know! Deep, we replaced the *Text Mapping* and *Read to Know* lessons with lessons that provided more practice with new vocabulary words (*Words to Know Practice*) and integrating information in texts (*Integration Practice*). This decision was grounded in feedback from our school partners and findings from formative research studies (LARRC, 2016); these lesson substitutions were the only difference between the two Let’s Know! instantiations. The Deep instantiation thus included six lesson types (but the same overall number of lessons) taught over the same period of time (see Table S.1). This afforded teachers needing to learn two fewer lesson types in the Deep instantiation, and children receiving twice as much practice on vocabulary and integration in each unit than in the Broad instantiation. Both instantiations were carefully designed to improve language comprehension skills reflected in the Simple View of Reading and both fit our proposed theory of change; however, the Deep instantiation provided the opportunity to determine whether simplified implementation and increased opportunities for practice would result in similar outcomes for children.

Our research team has published several papers reporting results of the iterative phases of Let’s Know! development. We first reported results of a quasi-experimental study in which we compared instruction during Let’s Know! lessons, as implemented by 40 teachers in their PK through Grade 3 classrooms, to that of their typical literacy instruction as well as to the typical instruction provided by comparison teachers (LARRC et al., 2014). We found that teachers used significantly more language-focused comprehension supports when implementing Let’s Know! than during non-Let’s Know! instruction and that Let’s Know! lessons heightened the instructional climate of classrooms as measured by the Instructional Support domain of the Classroom Assessment Scoring System (Pianta et al., 2004). In LARRC, Johanson et al. (2016), we reported results of another experimental pilot study involving PK teachers assigned to implement early versions of Let’s Know! Broad (*n* = 3) or Let’s Know! Deep (*n* = 4), or to a business-as-usual control condition (*n* = 4), and 49 children enrolled in these classrooms. Teachers in the Let’s Know! conditions implemented 21 weeks of the curriculum (three units) with the Broad instantiation including five lesson types and the Deep instantiation including three lesson types. We measured children’s comprehension-related skills (target vocabulary, comprehension monitoring, understanding narrative text comprehension and story grammar, understanding expository text) via CAMs as well as their language comprehension outcomes. On comprehension-related skills, children experiencing both instantiations improved their vocabulary compared to the control condition and also improved their comprehension monitoring for two of the three units. Children experiencing Let’s Know! Deep, but not those experiencing Let’s Know! Broad, outscored children in the control condition on the language comprehension outcome.

In LARRC et al. (2017), we reported initial findings concerning impacts of Let’s Know! on the comprehension-related skills of 766 children in PK through Grade 3. This study reported results from the first cohort enrolled in a randomized controlled trial, testing both instantiations against a business-as-usual control condition. We found large, statistically significant effects favoring the Let’s Know! conditions over control on CAMs assessing comprehension monitoring and vocabulary but minimal effects on CAMs assessing understanding narrative and expository texts. There were few differences between the instantiations. Finally, we reported additional results from this large randomized controlled trial in LARRC et al. (2019), examining the effects of Let’s Know! on the comprehension-related skills and reading comprehension outcomes across both cohorts of children in Grade 1 through Grade 3 (*n* = 938 children in 160 classrooms). We randomly assigned classrooms to Let’s Know! Broad, Let’s Know! Deep, or control conditions. Results showed that children in Let’s Know! classrooms scored significantly higher on CAMs assessing comprehension monitoring and vocabulary compared to control (effect sizes 0.55-1.98), and, in Grade 3 only, an additional advantage on the CAM assessing understanding narrative texts. We also found significant effects of Let’s Know! on reading comprehension outcomes relative to control, as mediated by effects on CAMs assessing vocabulary (effect sizes 1.89-2.26). These findings indicate that gains on comprehension-related skills may indirectly affect reading comprehension as a primary outcome of interest in Grades 1 through 3 and the need to evaluate such indirect effects for PK and K children, for whom language comprehension is the primary outcome.

## The Present Study

In the present study, we examined the intent-to-treat effects of the two instantiations of Let’s Know! on PK and K children’s comprehension-related language skills (i.e., those targeted in lessons and measured via CAMs) and language comprehension outcomes. Intent-to-treat analysis affords strong causal inference concerning intervention impacts (Sagarin et al., 2014) and aligns with the effects considered by the What Works Clearinghouse (WWC; Institute of Education Sciences, 2020). We addressed the following research questions: (1) To what extent do Let’s Know! Broad and Let’s Know! Deep impact the comprehension-related skills targeted in lessons? (2) To what extent do Let’s Know! Broad and Let’s Know! Deep impact children’s language comprehension outcomes? (3) Is there an indirect effect of the Let’s Know! instantiations on language comprehension outcomes through effects on comprehension-related skills? We hypothesized that Let’s Know! would positively affect targeted comprehension-related language skills relative to a business-as-usual control condition, and that impacts on language comprehension outcomes would be mediated by effects on the targeted skills (as aligned with our theory of change and supported by findings for children in Grade 1 through Grade 3; LARRC et al., 2019). However, we did not have a priori directional hypotheses regarding comparisons between the two Let’s Know! instantiations given equivocal results for impacts on comprehension-related skills in preliminary work with the grade levels included in the present study (LARRC et al., 2017).

# Method

**Participants**

The randomized controlled trial of Let’s Know! involved two sequential cohorts (2013-2014 or 2014-2015) of participating children and classrooms across six states. Classrooms were recruited by research staff based on administrator interest and approval, prior engagement in research partnerships, school or district size, geographic proximity to universities research labs, and diversity in enrollment. The total number of classrooms recruited was based on a priori power analyses, estimating a need for 65 classrooms per grade level and approximately six children per classroom to participate in study assessments.

In participating classrooms, teachers agreed to implement the Let’s Know! curriculum with their full class, if assigned, and to participate in study data collection activities. Additional requirements for PK classrooms included meeting at least 4 days per week and enrollment of children expected to matriculate to K in the following year. The caregivers of all children enrolled in participating classrooms received study information, consent forms, and a brief screening questionnaire. Research staff randomly selected up to six eligible children per classroom to participate in study assessments. Child eligibility criteria included: (a) provision of caregiver consent, (b) proficient in English as rated by the caregiver, (c) no severe or profound sensory or cognitive difficulties or diagnosed disabilities rendering study assessments inappropriate, and (d) expected to be present in the classroom during Let’s Know! lessons (e.g., not regularly engaged in intervention or activities external to the classroom during lesson time). If six or fewer children in a classroom met eligibility criteria, all eligible children were selected.

The analytic sample for the current study included all children who participated in any study assessments at any time point (*n* = 361 children from 69 PK classrooms; *n* = 328 children from 56 K classrooms; see Data Analysis Approach for classroom-level attrition and child-level non-response information). In Table 1, we present descriptive data by condition for teachers, classrooms, and children. In the PK sample, 52% were girls, and the average age was 54 months (*SD* = 4). The majority of PK children were non-Hispanic/Latinx (88%) and White (76%); 12% were Black, and 10% were of other or multiracial backgrounds. The majority (97%) had English as the primary home language; other primary home languages included Spanish (*n* = 5), Chinese (*n* = 2), and other (*n* = 3). Twenty-four percent of PK children had annual family incomes of less than $40,000; 25% had family incomes between $40,000 and $85,000, and 51% had family incomes greater than $85,000. Caregivers’ highest degrees included a high school diploma or less (35%), associates’ degree (8%), bachelors’ degree (33%), and graduate degree (24%). In the K sample, 49% were girls, and the average age was 66 months (*SD* = 4). The majority were non-Hispanic/Latinx (81%) and White (76%); 9% were Black and 15% were of other or multiracial backgrounds. Most (93%) had English as the primary home language; other primary home languages included Spanish (*n* = 12), Vietnamese (*n* = 1), and other (*n* = 2; unreported for two children whose primary home language was not English). Thirty-five percent of K children had annual family incomes of less than $40,000; 33% had family incomes between $40,000 and $85,000, and 32% had family incomes greater than $85,000. Caregivers’ highest degrees included a high school diploma or less (54%), associates’ degree (13%), bachelors’ degree (21%), and graduate degree (13%).

**Procedures**

All study procedures were approved by relevant Institutional Review Boards. Research staff randomly assigned intact classrooms to one of three study conditions prior to the start of the academic year: Let’s Know! Broad, Let’s Know! Deep, or business-as-usual control. Random assignment was blocked by university site and grade (see LARRC et al., 2017). Children in all classrooms completed pretest and posttest assessments administered by research staff at the beginning and end of the academic year, as well as curriculum-aligned measures (CAMs) administered by their classroom teachers at multiple time points during the year.

***Let’s Know! Conditions***

Children in classrooms assigned to one of the Let’s Know! conditions experienced the Let’s Know! lessons, as implemented by their classroom teachers, in addition to their typical classroom instruction. Teachers assigned to the Let’s Know! conditions reported typically spending between 31-45 min per day on language and literacy instruction in PK and 76-105 min per day in K. These teachers indicated using a variety of different curricula, including common commercially available curricula (more information provided in Supplementary Material).

Let’s Know! features 25 weeks of systematic and explicit language-focused instruction. Each week includes four 30-min whole-class lessons targeting specific lower-level and higher-level language skills. Lessons emphasize empirically validated instructional techniques for promoting language skills, follow a gradual release of responsibility model (Pearson & Gallagher, 1983) via an I Do, We Do, You Do approach, and are soft-scripted with suggested language for teachers. Lessons are organized thematically into four units, each of which features a different type of text structure. We provide an overview of the Let’s Know! units and the lesson types included in Let’s Know! Broad versus Let’s Know! Deep in Supplementary Material Table S.1. Instantiations differed only in lesson types; both targeted the same language skills, used the same instructional techniques, and provided the same number and duration of lessons. The teacher’s manual detailing the Let’s Know! scope and sequence, specific teaching strategies, lessons, and materials for implementation (e.g., books, manipulatives) is available for free download at https://larrc.ehe.osu.edu. For additional information concerning the design and development of Let’s Know!, see LARRC (2016).

Teachers in classrooms assigned to the Let’s Know! Broad or Let’s Know! Deep conditions received the corresponding teacher’s manual, all lessons and associated materials, and associated professional development. The latter consisted of an initial face-to-face meeting with research staff for an overview of the manual, lesson plans, and lesson types plus 6 hrs of online professional development modules (available at https://larrc.ehe.osu.edu). The online professional development included in-depth information concerning lesson content and implementation (e.g., specific instructional strategies used, video exemplars). Online professional development modules remained available for teachers to reference throughout implementation.

***Let’s Know! Implementation Fidelity***

Teachers assigned to the Let’s Know! conditions also received logs to document their lesson implementation. PK teachers reported implementing an average of 81% of lessons in the Let’s Know! Broad condition (range = 12% to 99%) and 69% in the Let’s Know! Deep condition (range = 14% to 100%). K teachers reported implementing an average of 85% lessons in the Let’s Know! Broad condition (range = 56% to 100%) and 84% in the Let’s Know! Deep condition (range = 33% to 100%). Additionally, research staff conducted videotaped observations of teachers’ implementation of Let’s Know! during seven randomly selected lessons. Trained coders used a fidelity checklist to indicate the extent to which teachers implemented key lesson features; 20% of these lessons were double coded and coders exhibited item-level exact agreement of 72% to 94% (*M* = 87%). Across all observations, PK teachers implemented an average of 80% of key lesson features (range = 50% to 90%) in the Let’s Know! Broad condition and 77% (range = 40% to 91%) in the Let’s Know! Deep condition. K teachers implemented 86% (range = 75% to 96%) and 85% (range = 69% to 96%) of key lesson features in the Let’s Know! Broad and Let’s Know! Deep conditions, respectively.

***Business-as-Usual Control Condition***

Given that Let’s Know! is a supplemental curriculum, our counterfactual comprised typical classroom language and literacy practices without additional language-focused instruction, as represented by a business-as-usual control condition. Children in business-as-usual control classrooms continued to experience their typical classroom instruction only. Teachers assigned to the control condition reported that they typically spent 31-45 min per day on language and literacy instruction in PK and 76-90 min per day in K; note that this was not statistically different from what teachers in Let’s Know! conditions reported (*p*s > .242). Like teachers in the Let’s Know! conditions, teachers assigned to the control condition reported using a variety of curricula (see Supplementary Material). Notably, of the curricula used, only Opening the World of Learning (Dickinson et al., 2014; reported for 4 classrooms) might be considered a language-focused curriculum. The comparison between Let’s Know! and control conditions represents whether Let’s Know! impacted the comprehension-related skills and/or language comprehension outcomes above and beyond use of these curricula or other typical classroom practices.

**Measures**

We include an overview of all measures in Supplementary Material Table S.2.

***Targeted Comprehension-Related Skills***

Let’s Know! includes CAMs embedded into Let’s Know! Show Me What You Know lessons. These CAMs served not only as progress monitoring and planning tools for teachers (i.e., to inform Stretch and Review lessons), but also as immediate measures of children’s learning of comprehension-related skills targeted within each unit. CAMs consisted of probes targeting lower- or higher-level language skills and were administered by classroom teachers towards the end of each Let’s Know! unit (i.e., four times across the year). At equivalent timepoints during the academic year, teachers in business-as-usual control classrooms also administered CAMs to children selected to participate in study assessments. All teachers followed standardized scripts and scoring protocols to administer the CAMs, and all received standardized training on administration and scoring via a narrated Powerpoint presentation that included video and scoring examples. During development of Let’s Know!, the research team confirmed that teachers could both administer and score CAMs with fidelity (LARRC, 2016). In this prior work, we audiorecorded administrations of CAMs; research staff verified adherence against an administration checklist and independently scored children’s responses for a randomly selected subsample. We found that teachers averaged 72% to 98% protocol adherence and exhibited 91% exact agreement with researcher scoring.

The *Vocabulary* probe assessed children’s learning of vocabulary targeted in the Let’s Know! curriculum. Taught words were selected based on frequency of appearance in children’s books, relevance to unit content, and utility (i.e., relevance across learning domains and contexts). Eight words from each Let’s Know! unit were included in that unit’s CAM. Teachers asked children to verbally define these eight words (e.g., “Tell me what *predator* means”) and could prompt for additional information if a response was incomplete (e.g., “Tell me more about *predator*”). Each word was scored as correct (2 points), partially correct (1 point), or incorrect (0 points). Summing across units provided a total score used in analyses (maximum possible = 64; ordinal *α* = .97 for both PK and K). We used summed scores for the Vocabulary and all other CAM probes given that each CAM was unit-specific and we could not assume equivalence of CAM items across units; this approach aligns with our prior work (LARRC et al., 2017, 2019).

The *Comprehension Monitoring* probe assessed children’s abilities to monitor their understanding of orally presented narrative or expository passages. Teachers asked children to listen to a short passage, identify what did not make sense, and suggest an appropriate fix-up strategy that could be used to resolve the problem. Examples of fix-up strategies include re-reading the sentence or surrounding text, finding the meaning of a word, and asking a teacher for clarification. Each item was scored via rubric as correct (2 points), correct after prompting (1 point), or incorrect (0 points). Summing across units provided a total score used in analyses (maximum possible = 16; ordinal *α* = .85 for PK; ordinal *α* = .86 for K).

The *Understanding Text* probe assessed children’s abilities to make inferences and use text structure to understand narrative and expository passages; this probe yielded three different scores. Narrative passages were used for *Understanding Narrative Text* probes in Units 1 and 4, each of which focused on narrative text. We selected multiple stories from the Test of Narrative Retell (Petersen & Spencer, 2012), which were counterbalanced across children (i.e., all children responded to all stories but in different orders). To administer the Understanding Narrative Text probe, the teacher read aloud one of the selected stories, audiorecorded the child retelling the story, and asked three comprehension questions. These questions required the child to make inferences related to story grammar elements and were developed by the research team based on the procedures outlined in Trabasso et al. (1988). The teacher then repeated this process with a second story; thus, each CAM involved the reading of two stories. The teacher scored the comprehension questions in real time as correct (1 point) or incorrect (0 points); summing across the two narrative units (four stories total) provided the total score used in analyses (maximum possible = 12; ordinal *α* = 0.91 for PK; ordinal *α* = 0.86 for K). Research staff used the Test of Narrative Retell rubrics to score the audiorecorded retell for inclusion of key story grammar elements (additional information provided below). Summing across stories (two per unit) and the two narrative units provided the total story grammar score used in analyses (PK maximum possible = 56, Cronbach’s *α* = .78; K maximum possible = 72; Cronbach’s *α* = .68).

Units 2 and 3 focused on expository, rather than narrative, text. Because no measure comparable to the Test of Narrative Retell exists for expository text, the research team developed expository passages and corresponding comprehension questions for use in the Units 2 and 3 *Understanding Expository Text* probes. The passages aligned with the content of the units, in terms of both topic (i.e., animals or earth materials) and text structure (e.g., compare-contrast, cycles). Administration and scoring paralleled that for the Understanding Narrative Text probes. The teacher read aloud one passage, asked two multiple choice comprehension questions that required the child to identify the main idea or supporting details, and then repeated this process with the second passage. The teacher scored the comprehension questions in real time as correct (1 point) or incorrect (0 points). Summing across stories and units provided the total score used in analyses (maximum possible = 8; ordinal *α* = .52 for PK; ordinal *α* = .60 for K). Although the reliabilities for this probe are lower than for other measures, potentially due to the limited number of items, these exceed the minimum standard set by the WWC (Institute of Education Sciences, 2020, p. 83).

***Language Comprehension Outcomes***

At the beginning (pretest) and end (outcome) of the academic year, research staff administered two standardized language comprehension assessments, the Test of Narrative Retell (TNR; Petersen & Spencer, 2012) and the Test of Narrative Language (TNL; Gillam & Pearson, 2004). These were our primary language comprehension outcome measures (see Clarke et al., 2010). Research staff also assessed children’s comprehension of vocabulary targeted in Let’s Know!, as a secondary language comprehension outcome. This vocabulary assessment differed from the immediate, unit-specific CAM vocabulary probe not only in proximity to the time of instructional delivery but also in content, and was constructed to reflect learning across the entire curriculum. These pretest and outcome assessments were administered individually in quiet locations at children’s PK centers or schools. The research staff administering assessments in the field completed a standardized training that included reviewing administration protocols, viewing narrated Powerpoint presentations with embedded videos of correct administration, achieving at least 80% correct on administration quizzes, and successfully completing two administrations while being observed by senior staff. Scoring of the TNR and TNL required research staff to code children’s audiorecorded responses following procedures outlined in the assessment manuals. Research staff scoring the assessments also completed standardized training that included reviewing scoring guidelines, practicing scoring, and achieving at least 90% agreement with a set of master-coded responses. For the TNR, 10% of audiorecordings were randomly selected for double coding; intraclass correlations (ICCs) exceeded .89. For the TNL, prior studies involving the same research staff showed ICCs greater than .95 over three consecutive years of coding (LARRC, Farquharson et al., 2016); given such high reliability, we did not complete additional double coding in the current study.

The TNR measures children’s comprehension of orally presented stories via the quality of their retellings. Prior research supports the utility and validity of retellings as a measure of young children’s comprehension (e.g., Griffin et al., 2004; Lynch et al., 2008; Sénéchal & Lever, 2014). Research staff read aloud two stories at both pretest and posttest and audiorecorded children’s retellings of each story. As noted when describing the CAMs, we counterbalanced stories across children and assessment points, such that all children heard and responded to all stories but in different orders. Retells are coded with respect to two indicators of narrative comprehension: *story grammar* and *story* *cohesion* (Sénéchal & Lever, 2014). The TNR story grammar rubric measures the extent to which retellings include key story grammar elements (character, setting, problem, emotion, plan, attempt, consequence, resolution), based on the story schema detailed by Stein and Glenn (1982). Each retell can be awarded up to 14 story grammar points in PK and 18 in K for total scores of up to 28 or 36, respectively, across two stories. Story cohesion, measured via the TNR language complexity rubric, signifies the extent to which children use temporal and causal connectives (i.e., then, because, when, after) to explicitly mark relations between different story elements and episodes in their retells. Each retell can be awarded up to 10 story cohesion points, for total scores of up to 20 points across two stories. Additionally, as noted above, research staff developed three *comprehension* questions for each story, based on the procedures outlined in Trabasso et al. (1988). Children were asked these comprehension questions immediately after providing their retellings. Children’s responses were scored as correct (1 point) or incorrect (0 points), for a total possible score of 6 across the two stories (ordinal α = .74 for PK; ordinal α = .72 for K).

We also used the receptive portion of the TNL to measure children’s language comprehension. Children listened to three orally presented stories and answered *comprehension* questions after each story. Responses were audiorecorded and scored as correct (1 point) or incorrect (0 points) for a total possible score of 40 (ordinal α = .89 for PK; ordinal α = .86 for K).

The *Let’s Know! Vocabulary* measure included four vocabulary words from each unit (i.e., 16 words). Children were asked to verbally define each word. Research staff scored each word as correct (2 points), partially correct (1 point), or incorrect (0 points) for a total possible score of 32 (ordinal α = .91 for PK; ordinal α = .86 for K). The measure also included three “easy” words, on which children were expected to be able to provide definitions, in order to boost confidence and persistence on the task; these were not scored.

**Data Analysis Approach**

We conducted all data analyses using *R*, *SPSS*, and *MPlus*. Our a priori analysis approach began with investigation of distributional characteristics of our variables followed by preliminary analyses to examine classroom-level attrition and child-level non-response (missingness), initial equivalence, and potential cohort differences. We used a research-informed approach to multiple imputation for multilevel data as further described below. To investigate the first two research questions, we estimated random intercept models with all-pairwise comparisons to assess differences between the two Let’s Know! instantiations and the control condition. We used the Benjamini-Hochberg procedure to correct for multiple comparisons (Benjamini & Hochberg, 1995). All variables exhibited approximately normal distributions in our samples, with two exceptions. First, for TNR story grammar in both PK and K, scores were positively skewed with a large number of children scoring zero. Second, scores in the K sample for TNR story cohesion were non-normally distributed with many zeros and positive skew. Thus, for these outcomes, we estimated alternative multilevel models appropriate for these distributions, as noted below. To investigate the third research question regarding indirect effects, we used multilevel structural equation modeling. Further details on our approach for preliminary analyses, multiple imputation, and main analyses are provided below.

***Preliminary Analysis Approach***

Prior to analyzing study data, we followed WWC standards (Institute of Education Sciences, 2020) to clarify impact of attrition at the cluster (classroom/teacher) level as well as for child-level missingness from non-attriting clusters prior to imputation. Classroom-level attrition occurred after randomization but prior to administration of study measures. Our initial study sample included 74 PK classrooms (21 Let’s Know! Broad, 25 Let’s Know! Deep, and 28 control classrooms corresponding to *n* = 398 children overall; 116, 134, and 148 children in each condition, respectively) and 57 K classrooms (20 Let’s Know! Broad, 19 Let’s Know! Deep, and 18 control classrooms corresponding to *n* = 337 children; 119, 115, and 103 children in each condition, respectively). By condition, classroom-level attrition rates at PK were low: 2.7% (2 classrooms; *n* = 12 children) Let’s Know! Broad; 3.4% (3 classrooms; *n* = 17 children) Let’s Know! Deep; and 0% control. Relative to the overall PK classroom-level attrition rate (5 classrooms, 6.8%), differential attrition between conditions was also low suggesting minimal threat of potential bias due to classroom-level attrition (Institute of Education Sciences, 2020, p. 10). Similarly for K, condition-specific classroom-level attrition rates (0% Let’s Know! Broad; 0% Let’s Know! Deep; 5.6% [1 classroom; 6 children] control) were low, and differential attrition between conditions relative to the overall K classroom-level attrition rate (1 classroom, 1.8%) were also low, suggesting minimal threat of potential bias due to classroom attrition in K. Reasons for classroom-level attrition included teacher turnover in PK, time or scheduling concerns given constraints of half-day PK, and conflicts with existing assessment requirements at the school.

We assessed child-level attrition as child non-response to outcome measures based on all children in non-attriting classrooms prior to imputation (Institute of Education Sciences, 2020). For the non-attriting classrooms in PK (69 classrooms, *n* = 369 children), eight children provided no data on any of the study measures. In K (56 classrooms, *n* = 331 children), three children contributed no data on study measures. Children contributing no data on the set of targeted, primary, and secondary outcome measures were included for attrition assessment but they were not considered part of the analytic sample and their data were not imputed. For children in non-attrtiting classrooms, non-response rates and differential response rates by measure for PK and K comprehension-related skills and language comprehension outcomes are provided in Supplementary Material Tables S.3 and S.4, respectively, and we followed the same procedure as above for assessing risk of bias in experimental comparisons (Institute of Education Sciences, 2020). In non-attriting classrooms, for targeted comprehension-related skills (i.e., CAMs administered by teachers), non-response ranged from 24.4% to 40.4% in PK and 18.1% to 22.4% in K. In comparison, language comprehension outcome measures administered by researchers had much less missing data, ranging from 11.9% to 19.5% in PK and 10.0% to 12.1% in K. Comparing across conditions for each outcome measure in Tables S.3 and S.4, differential non-response relative to overall non-response indicated tolerable ranges for potential bias of experimental comparisons for the language comprehension measures in both PK and K, with one exception in PK for the comparison between Let’s Know! Broad and control on TNR comprehension, and one exception in K for the comparison between Let’s Know! Broad and Let’s Know! Deep on Let’s Know! Vocabulary. For most of the comparisons involving teacher-administered measures in K, differential non-response rates relative to overall were in tolerable ranges for potential bias, but were much higher for nearly all comparisons involving teacher-administered assessments at PK, indicating greater risk for potential bias in these experimental comparisons.

Excluding the thirteen children who contributed no outcome data in non-attriting clusters, our analytic sample contained 69 PK classrooms with *n* = 361 children, and 56 K classrooms with *n* = 328 children. We compared characteristics of children included in the analytic sample to those excluded due to classroom attrition or due to missingness for all outcome variables on all background characteristics indicated in Table 1. We made these comparisons using Chi-square tests for categorical data and ANOVAs with pairwise comparisons for continuous data (substituting Welch tests when homogeneity of variance was violated).

Although we used random assignment to theoretically equate study conditions on all measured and unmeasured participant characteristics (Sagarin et al., 2014; Shadish et al., 2002), we followed recommendations to directly examine potential non-equivalence across teacher, classroom, and child characteristics and include any variables found to have differential effects across conditions as covariates in the main analyses (Institute of Education Sciences, 2020; Shadish et al., 2002). We compared conditions on each of the characteristics listed in Table 1 as well as all pretest scores, again using Chi-square tests for categorical data and ANOVAs with pairwise comparisons for continuous data (substituting Welch tests when homogeneity of variance was violated). Additionally, because the study included two sequential cohorts of participants, we conducted independent samples *t*-tests to identify any cohort differences on our measures of interest; if we detected cohort differences, we planned to included cohort as a covariate in all main analyses.

***Imputation Approach***

In preparation for imputation, we investigated the presence and degree of missing data for all outcome measures in our analytic sample. We handled missing data via multiple imputation (Little & Rubin, 1987) accounting for clustering by classroom, in M*plus* version 7.4 (Muthén & Muthén, 1998-2012). We used an unrestricted variance-covariance model (Asparouhov & Muthén, 2010) in which all variances and covariances are estimated freely from the data. According to Asparouhov and Muthén, the use of an unrestricted variance-covariance model for missing values imputation is general enough to avoid model misspecification.

We conducted multilevel inclusive imputation (Schafer & Olsen, 1998) separately for PK and K. An inclusive analysis strategy is recommended when determining the set of variables to be included in the imputation model (Collins et al., 2001; Enders, 2010; Schafer & Olsen, 1998). In an inclusive approach, all variables to be used in subsequent analytic models are included in the imputation model along with auxiliary variables that are not part of the analysis models but are either associated with the outcomes or with missingness, thus reducing estimation biases and increasing the chance of satisfying the missing at random assumption (Collins et al., 2001; Enders, 2010; Graham, 2012). Thus, the imputation model included measures of all comprehension-related skills and language comprehension outcomes as well as other variables that were empirically (based on preliminary analyses) or theoretically related to the missingness or outcomes (i.e., auxiliary variables). We provide a correlation matrix of all variables included in the imputation model in Supplementary Material Tables S.5 (PK) and S.6 (K). Missing data for each of the study variables in the analytic sample, including pretest language comprehension scores, ranged from 2.8% to 39.1% in PK and 4.3% to 21.6% in K. Given our overall low fraction of missing information (< 30%), we imputed 20 datasets as recommended in Graham (2012, p. 62).

***Approach for Main Analyses***

We analyzed the imputed data to address our main analyses using M*plus* and report results from combining across the 20 sets of analyses. To investigate our first research question, we estimated separate normal-outcome random-intercept models by grade (children nested within PK or K classrooms) to determine the effects of Let’s Know! on targeted comprehension-related skills (i.e., Vocabulary, Comprehension Monitoring, Understanding Narrative Text, Story Grammar, and Understanding Expository Text CAMs). We dummy coded condition to serve as the independent variable of interest, with dummy codes rotated to estimate all pairwise comparisons. Because random assignment was blocked by site, we included site as a covariate in these and other main analyses as well as all covariates identified in the preliminary analyses. We computed effect sizes (*d*) using , in which represents the unstandardized regression coefficient from the random intercepts model, and and represent the level-2 variance component and variance of level-1 residuals, respectively, from the unconditional model (Spybrook et al., 2011). We also estimated ICCs from the unconditional model following Raudenbush and Bryk (2002).

To investigate our second research question regarding effects of Let’s Know! on language comprehension outcomes, we used similar analyses as above. Again, we estimated random-intercepts models for each measure and grade separately. These models included pretest scores on the relevant outcome (e.g., pretest TNL comprehension scores when analyzing TNL comprehension outcomes) in addition to condition, site, and the covariates identified in preliminary analyses. Effect sizes and ICCs were determined as above. Because the TNR story grammar scores in PK and K were not normally distributed with a large number of children scoring zero, we estimated two-part multilevel models for TNR story grammar to appropriately account for the zero-inflation. The PK results for the two-part model paralleled those from a conventional multilevel model, so we report results for the latter for ease of interpretation. Additionally, the TNR story cohesion scores in the K sample were non-normally distributed with many zeros and positive skew. Given the distribution, we analyzed this outcome as count data using multilevel negative binomial regression and report incident rate ratios, defined as eCoef., for effect sizes. The incident rate ratios represent the change in expected counts for the two conditions being compared, controlling for covariates. We followed Leckie et al. (2020) for estimation of the ICC for multilevel negative binomial models.

To investigate our third research question, we examined potential indirect effects of Let’s Know! on language comprehension outcomes through effects on the targeted comprehension-related skills (i.e., CAMs) using 2-1-1 random intercepts multilevel structural equation models (Preacher et al., 2010). We considered mediation models only for those language comprehension outcomes that exhibited significant classroom variation in initial unconditional models and only considered as mediators those targeted comprehension-related skills on which Let’s Know! exhibited direct impacts. We estimated separate models for PK and K and for each language comprehension outcome. All models included pretest scores for the language outcomes modeled as well as site and covariates identified in preliminary analyses. We examined model fit with respect to Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Standardized Root Mean Square Residual (SRMR). Models with RMSEA less than .10, CFI of at least .90, and SRMR less than .08 are considered to have acceptable fit (Hu & Bentler, 1999; MacCallum et al., 1996).

**Results**

**Findings from Preliminary Analyses**

The analytic samples for this study included all children who participated in any of the study assessments described above at any time point. Of children initially selected to participate in study assessments, 37 PK children and 9 K children were not included in analyses due to classroom attrition or missing outcomes on all study data. In PK, children excluded from the analytic sample were less likely to be White and had lower levels of caregiver education than those included in the PK analytic sample. There were no significant differences between K children excluded from the analytic sample and those included in the K analytic sample. All following analyses were conducted on the analytic samples.

When testing for initial equivalence across conditions, we found no differences across conditions for any teacher or classroom characteristics (*p*s > .114 with the exception of commercial curriculum use in the PK sample for which *p* = .07). In the PK sample, children assigned to the Let’s Know! Deep condition had initially higher Let’s Know! Vocabulary pretest scores than those assigned to the control condition, *t*(194.66)= -2.80, *p* = .006, and those assigned to the Let’s Know! Broad condition had significantly lower pretest TNR story cohesion scores than those assigned to the control condition*, t*(221.73) = 2.51, *p* = .013. We thus included pretest Let’s Know! Vocabulary and TNR story cohesion scores as covariates in all main PK analyses. In the K sample, the percentage of children from a home with a primary spoken language other than English differed slightly among conditions, χ2 (2, *N* = 242) = 6.36, *p* = .042 although overall percentages were small (4.1%, 12.5%, 3.7% for control, Let’s Know! Broad, and Let’s Know! Deep, respectively). Other reported languages included Spanish (*n* = 1, 8, and 3 for control, Let’s Know! Broad, and Let’s Know! Deep, respectively), Vietnamese (*n* = 1 for control), and languages other than those listed (*n* = 2 for Let’s Know! Broad). We included whether English was the primary home language as a covariate in all main K analyses.

We observed cohort differences for several of our primary measures in both PK and K. Thus, in addition to the above covariates, we also included cohort as a covariate in our main analyses.

**Impacts of Let’s Know! on Targeted Comprehension-Related Skills**

Our first research question concerned the impact of Let’s Know! on children’s targeted comprehension-related skills, indexed by the five CAM scores (Vocabulary, Comprehension Monitoring, Understanding Narrative Text, Story Grammar, and Understanding Expository Text). Results for PK comparisons on comprehension-related skills are presented in the top section of Table 2; these and all other reported results reflect application of the Benjamini-Hochberg correction. ICCs ranged from .17 to .64, indicating a considerable amount of variation across classrooms and supporting use of multilevel analysis. We note that the ICC of .64 was for the Vocabulary probe, reflecting the fact that the targeted vocabulary words were taught only in classrooms assigned to the Let’s Know! conditions. Both Let’s Know! conditions showed significant and positive impacts on Vocabulary and Comprehension Monitoring relative to the business-as-usual control condition, with effect sizes of 0.55 to 1.22. Let’s Know! Deep also positively impacted Understanding of Expository Text relative to control, with *d* = 0.49. No other comparisons were statistically significant.

Results for K comparisons on comprehension-related skills are presented in the top section of Table 3. ICCs ranged from .10 to .62, with the large ICC again for the Vocabulary probe. Similar to the PK results, both Let’s Know! conditions showed significant and positive impacts on Vocabulary and Comprehension Monitoring relative to the control condition, with effect sizes of 1.01 to 1.55. No other comparisons were statistically significant.

**Impacts of Let’s Know! on Language Comprehension Outcomes**

Our second research question concerned the impact of Let’s Know! on children’s primary language comprehension outcomes, measured via the TNR and TNL, as well as Let’s Know! vocabulary as a secondary outcome. Results for PK comparisons on language comprehension outcomes are presented in the bottom section of Table 2. ICCs ranged from .00 to .44. Both Let’s Know! conditions significantly and positively impacted the secondary language outcome, Let’s Know! Vocabulary, relative to the control condition (effect sizes = 0.69 to 0.74). None of the comparisons for primary outcomes were statistically significant.

Results for K comparisons on language comprehension outcomes are presented in the bottom section of Table 3. ICCs ranged from .08 to .48. Similar to PK, both Let’s Know! conditions positively impacted Let’s Know! Vocabulary relative to the control condition (effect sizes = 0.76 to 1.12). Only one other comparison was statistically significant in K, with lower TNR comprehension scores in the Let’s Know! Deep condition compared to control, *d* = -0.39.

**Indirect Effects of Let’s Know! on Language Comprehension**

To address our third research question regarding indirect effects of Let’s Know! on language comprehension outcomes through effects on targeted comprehension-related skills, we conducted multilevel mediation models for both PK and K. As indicated by the ICCs noted above, several language comprehension outcomes did not exhibit significant between-classroom variation in our unconditional models. Accordingly, we did not test multilevel mediation models for TNR story cohesion or TNR story grammar in PK, or TNR story grammar in K. We also only considered as potential mediators those comprehension-related skills on which Let’s Know! exhibited direct impacts. This included Comprehension Monitoring, Vocabulary, and Understanding Expository Text for PK, and Comprehension Monitoring and Vocabulary for K.

Results of the mediation analyses for PK, along with the path diagram, are presented in Figure 1. For all three language comprehension outcomes, the models had acceptable fit (RMSEA < .10; CFI > .95; SRMR < .08). Only the model for Let’s Know! Vocabulary showed significant indirect effects (RMSEA = .084; CFI = .982; SRMR within = .007; SRMR between = .032). In this model, both Let’s Know! conditions indirectly impacted the Vocabulary outcome through effects on the CAM Vocabulary probe.

Results of the mediation analyses for K are presented in Figure 2. Consistent with the distributional issues discussed above in our Data Analysis Approach section, we analyzed TNR story cohesion scores as count data (Preacher et al., 2010; Zhang et al., 2009)*.* We examined Akaike information criterion (AIC) and Schwartz’s Bayesian information criterion (BIC) to determine model fit in this case. The K models had acceptable fit for all language comprehension outcomes (RMSEA < .10; CFI > .95; SRMR < .08) including TNR story cohesion (AIC = 5506.53., BIC = 5646.88). Similar to the PK results, the model for Let’s Know! Vocabulary showed significant indirect effects (RMSEA = .066; CFI = .994; SRMR within = .003; SRMR between = .021). Both Let’s Know! conditions indirectly impacted the Vocabulary outcome through effects on the CAM Vocabulary probe. Results did not indicate indirect effects for any other language comprehension outcome.

# Discussion

Whereas a large body of research has established how to teach word reading, the research base for teaching skills related to language and reading comprehension is significantly smaller (Castles et al., 2018; Douglas & Albro, 2014). In this study, we examined the effects of Let’s Know!, a curriculum designed to bring about changes in lower-level and higher-level language skills as a way to support overall language comprehension, with the ultimate goal of improving later reading comprehension. Although decades of research support positive associations between oral language in young children and later reading abilities (Hjetland et al., 2020; National Early Literacy Panel, 2008), Let’s Know! is currently one of very few Tier 1 curricula available to provide targeted instruction across multiple dimensions of language in PK and elementary classrooms (cf. Clarke et al., 2010; Fricke et al., 2013).

We hypothesized that Let’s Know! would impact both the comprehension-related skills targeted in the intervention and also broader language comprehension outcomes. We further hypothesized that the effects on the primary and secondary language outcomes would be mediated through effects on targeted skills. Our findings only partially support these hypotheses. We found that Let’s Know! benefitted children’s vocabulary knowledge, comprehension monitoring, and, to some extent, understanding of expository text when measured by CAMs embedded in the lesson units. When considering broader language outcomes, Let’s Know! again impacted consolidated learning of vocabulary but not other measures of language comprehension, and these effects were mediated by children’s vocabulary learning as measured during the units (i.e., in close proximity to when the words were initially taught). We found no further evidence of mediation. Below, we interpret and provide possible explanations for this pattern of findings.

We first consider the positive effects of Let’s Know! on our targeted curriculum-aligned measures, particularly vocabulary and comprehension monitoring. The positive impact of instruction on these skills has practical and theoretical implications as both make a significant contribution to reading comprehension (LARRC, 2015; Oakhill & Cain, 2012) and are causally implicated in reading comprehension difficulties (Cain & Oakhill, 2006; Nation et al., 2004). Effects were moderate to large, with those for vocabulary ranging from 0.90 to 1.55 and effects on comprehension monitoring ranging from 0.55 to 1.05. This converges with earlier research examining the impacts of Let’s Know! for children in primary grades (LARRC et al., 2017, 2019). In comparison, in their recent meta-analysis regarding the effects of language intervention, Silverman et al. (2020) reported an average effect of 1.27 (95% confidence interval [CI]: 0.90-1.64) for “custom” measures of vocabulary skills. For other language measures, Silverman et al. (2020) reported average effect sizes ranging from 0.01 (standardized measures of syntax) to 1.14 (custom measures of morphology). The average effect on broad language comprehension measures was 0.10 (95% CI: 0.05-0.32, which is similar to the average effect reported by Rogde et al. (2019) in their meta-analysis (0.16; 95% CI: 0.10-0.22).

The positive effects related to vocabulary knowledge are important as vocabulary is strongly implicated both empirically and theoretically in reading comprehension performance (Cain et al., 2004; LARRC, 2015; Perfetti & Stafura, 2014). The strong effects found here suggest that robust vocabulary learning occurs when target words are explicitly taught in context and children are given multiple opportunities to discuss components of the vocabulary word in context. Vocabulary is not well targeted in currently available PK and K curricula (Neuman & Dwyer, 2009; Wright & Neuman, 2014) and, when it is included, the instruction often consists of brief, unplanned explanations of word definitions. Furthermore, Wright and Neuman (2014) found that the target words chosen by teachers tended to be simple words that children likely already knew, at least partially; the target words selected in Let’s Know! were chosen to be highly related to unit content and also lower frequency than those typically heard in conversation (e.g., crevice, solution, compare). Based on our work, as well as those of colleagues who implemented carefully planned vocabulary instruction with young children (Catts et al., 2016; Coyne et al., 2010; Marulis & Neuman, 2010), we propose that systematic, explicit instruction, with intentional selection of more complex vocabulary words, has the potential to improve children’s vocabulary. It is true that children in the control condition did not receive explicit instruction on the selected Let’s Know! vocabulary words, so the effect sizes may not be surprising (see also Clarke et al., 2010 for similar design and findings). However, these large effects do show that children exposed to instruction are learning vocabulary related to curricular content, which is an important component of comprehension, and this learning occurred during a classroom-wide intervention led by classroom teachers rather than a small-group intervention led by interventionists; the latter is frequent in research studies (e.g., see Rogde et al., 2019). Furthermore, our posttest vocabulary measure included words that had not been addressed directly in instruction for many months and therefore provides evidence that children maintained knowledge of words learned. A remaining question is whether this type of learning generalizes to vocabulary learning, or language learning, more broadly (Coyne et al., 2010).

In addition to vocabulary, Let’s Know! successfully impacted children’s comprehension monitoring skills. The ability to read or listen to text and identify a failure of comprehension is an important component of understanding written text (Cain et al., 2004; LARRC & Yeomans-Maldonado, 2017). To date, most empirical research has examined comprehension monitoring instruction with older children (e.g., McKeown et al., 2009; Wassenburg et al., 2015); our positive findings are promising with respect to improving this ability in younger children (see also Baker, 1984; de Sousa & Oakhill, 1996).These results suggest that the implementation of a language-focused intervention such as Let’s Know! has the potential to affect young children’s abilities to use fix-up strategies to reconcile inconsistencies in their comprehension of written text. Additional studies should be conducted to further examine the immediate and longer-term effects of comprehension monitoring instruction with young children.

With respect to the measures of other targeted comprehension-related skills, we noted one effect on the understanding of expository text but none on the understanding of narrative text. This might be related to the frequency and/or intensity of instruction related to a particular genre. When developing Let’s Know!, and as informed by the literature, the research team felt it was important to expose children to both expository and narrative texts. The Common Core State Standards (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) emphasize the importance of including expository texts in classroom and instruction. For both exposure and instruction, a ratio of 50% narrative and 50% expository text has been recommended for children in K. However, the inclusion of both text structures might have had the adverse effect of diluting the intensity of the instruction and practice on applying skills to a particular genre. Additionally, PK and K teachers tend to devote instructional time to narratives but focus less on expository text (Duke, 2000). Thus, children may have been afforded opportunities to learn about narratives regardless of condition, whereas Let’s Know! provided specific opportunities to learn about expository text structures. It is also possible that Let’s Know! provided an impetus for some teachers to increase their integration and reinforcement of expository text skills as part of their regular instruction.

Somewhat disappointing was the lack of effects on the primary language comprehension outcomes. These results were not entirely surprising, however, as previous studies highlighting language instruction have also shown somewhat limited success (Rogde et al., 2019; Silverman et al., 2020). Notably, our findings do not align with our proposed theory of change, in which we expected that explicit instruction in specific lower- and higher-level language skills would generalize to broad, more general, language comprehension outcomes. We also tested this theory of change in our mediation analysis but, again, did not find evidence that increases in targeted skills led to increases in primary language comprehension outcomes. Although it makes sense that intervening on component skills such as alphabet knowledge and phonemic awareness generalize to word reading ability, it may not be the case that targeting only oral language skills such as narration and vocabulary transfer as readily to more general measures of language comprehension.

Arguably, comprehension—whether language or reading comprehension—is more fluid and complex than word reading and involves not only language and other cognitive skills but also consideration of the reader (e.g., background knowledge, purpose for listening/reading, curriculum exposure) and the text itself (Catts & Kamhi, 2014; Snow, 2018). Instruction that has targeted not only specific language skills, but also the cognitive skills that support language comprehension such as regulation and working memory, have found transfer effects to listening and reading comprehension (Carretti et al., 2014). Thus, our instructional curriculum and its assessment may not have captured all of the multiple components that influence listening and reading comprehension. Given that standardized measures of comprehension tend to require children to respond to particular passages without necessarily accounting for reader or text characteristics, we might expect language-focused instruction to affect skills measured in ways that more closely mirror the curriculum (e.g., our CAMs) but not transfer to measures that are not at all related to classroom instruction (Catts & Kamhi, 2014). Our particular measures of language comprehension also had somewhat restricted ranges, and very small differences were noted for most outcome measures beyond vocabulary, making it unlikely to find indirect effects on these outcomes.

Further aspects of Let’s Know! and its implementation might also explain the lack of effects. The curriculum was intentionally designed to comprehensively target language, based on the research team’s extensive review of the evidence base. Although participating children received 120 minutes per week of total language instruction, the time devoted to any one skill was substantially less than that, and the instructional intensity—or balance across skills—might have been ineffective. The use of whole-class instruction may also have led to attenuated effects. It may be that we were not serving the population most in need of this language support, and the effects of Let’s Know! for children identified as at risk for language or comprehension difficulties should be investigated in future work. Moreover, a recent meta-analysis found that language instruction provided to small groups was more effective than when provided to whole classrooms (Rogde et al., 2019). However, our goal was to create a Tier 1 curriculum that increased language instruction for all children, based in our understanding that many children are in need of comprehension support and feedback from practitioners indicating that asking teachers to conduct multiple small groups of repeated instruction every week is unrealistic. It is promising that even within a whole classroom setting, effects were noted on select language skills.

Additionally, in our study, classroom teachers enacted all instruction, as opposed to implementation by trained research staff as is often the case in intervention studies (e.g., Catts et al., 2016; Connor et al., 2018; Lonigan & Phillips, 2016). We know through informal communications with Let’s Know! teachers that some felt less-skilled at delivering certain types of lessons. Also, teachers were expected to implement instruction to support a broad range of language skills instead of honing in on one particular skill, which might have affected success at delivering the various lesson types as intended. Although our overall levels of fidelity might be considered high, there was great variability across teachers. This variability occurred even with focused professional development and soft-scripted lessons that provided guidance and explicit models on how to use specific language-facilitating techniques. Teacher or classroom characteristics that may account for this variance in teacher implementation deserves further attention in future work.

## Limitations and Implications for Future Research

One limitation of this study is that the current results do not take into account variability in implementation and possibly in training (e.g., if some teachers referenced the online professional development modules for further guidance as they implemented the lessons); we see this as an important avenue for continued analysis but our initial focus was on intent-to-treat results that allowed for causal interpretation. Second, although we were confident that teachers could administer and score the CAMs as intended, based on our pilot work and prior literature showing fidelity and scoring reliability for similar teacher-administered progress monitoring measures (Spencer et al., 2017; Wackerle-Hollman et al., 2015), we did not directly measure this in the current study. Third, we were only able to assess the immediate impacts of Let’s Know!. It may be that multiple years of high-quality language-focused instruction are necessary to achieve intended results; ideally, impacts on language should be examined longitudinally, culminating with effects on reading comprehension. Related to this, and our theory of change, researchers might also test whether a broader range of language and cognitive skills should be targeted to achieve robust transfer effects. Fourth, because of the volume of PK centers and schools participating in this study, what constituted “typical” practice varied considerably. Although this contributes to the generalizability of our findings, better understanding how Let’s Know!, as a supplemental curriculum, does or does not align with other classroom practices deserves further attention. More information about practices in the business-as-usual control condition is also desirable in future work, in considering the implications of the counterfactual. Relatedly, in accordance with human subjects protections, all participating teachers were volunteers and, initially unaware of the condition to which they would be assigned, all were willing to trial Let’s Know!. These teachers—including those assigned to the control condition—may have been highly interested in supporting children’s language skills and providing high-quality instruction to this end, making it more difficult to detect differences between conditions. This may limit generalizability of findings.

In close, it is possible that we may need to refine our thinking as to how to support children’s language comprehension skills. We have demonstrated that language-focused supplemental instruction benefits language skills shown empirically and theoretically to be related to listening and reading comprehension. Although well-defined, shorter-term academic interventions have been successful in facilitating word reading, this approach may not be sufficient for substantially impacting language comprehension. The field may need to grapple with how to further identify, develop, and evaluate classroom practices that boost these (and potentially other) key skills and also to design better outcome measures that capture the complexity and multidimensionality of comprehension. Such work requires not only substantial commitments from involved researchers and practitioners but also financial commitments from funders to afford sustained, multiyear efforts and longitudinal assessment of children. This is a priority investment, given the long-term impact of literacy on both individuals and society as a whole (World Literacy Foundation, 2015).

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Table 1

*Descriptive statistics for prekindergarten and kindergarten analytic samples*

|  | Prekindergarten analytic sample  (*n* = 361 children, 69 classrooms) | | | | | | | | | | |  | Kindergarten analytic sample  (*n* = 328 children, 56 classrooms) | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Let’s Know! Broad | | |  | Let’s Know!  Deep | | |  | Control | | |  | Let’s Know! Broad | | |  | Let’s Know!  Deep | | |  | Control | | |
|  |  | *n* | % |  |  | *n* | % |  |  | *n* | % |  |  | *n* | % |  |  | *n* | % |  |  | *n* | % |
| Children  (classrooms) |  | 102 (19) |  |  |  | 116 (22) |  |  |  | 143 (28) |  |  |  | 117 (20) |  |  |  | 115 (19) |  |  |  | 96 (17) |  |
| Teacher/classroom characteristics | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Female |  | 13 | 100.0 |  |  | 20 | 100.0 |  |  | 25 | 96.2 |  |  | 19 | 100.0 |  |  | 17 | 94.4 |  |  | 15 | 100.0 |
| White |  | 10 | 76.9 |  |  | 17 | 89.5 |  |  | 18 | 69.2 |  |  | 16 | 84.2 |  |  | 17 | 94.4 |  |  | 14 | 93.3 |
| Hispanic/Latinx |  | 1 | 7.7 |  |  | 2 | 10.0 |  |  | 2 | 7.7 |  |  | 2 | 10.5 |  |  | 2 | 11.1 |  |  | 0 | 0.0 |
| Highest Degree |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| HS diploma or  Associates |  | 5 | 38.5 |  |  | 7 | 35.0 |  |  | 8 | 30.8 |  |  | 0 | 0.0 |  |  | 0 | 0.0 |  |  | 0 | 0.0 |
| Bachelors |  | 2 | 15.4 |  |  | 7 | 35.0 |  |  | 8 | 30.8 |  |  | 5 | 26.3 |  |  | 4 | 22.2 |  |  | 3 | 20.0 |
| Graduate |  | 6 | 46.2 |  |  | 6 | 30.0 |  |  | 10 | 38.5 |  |  | 14 | 73.7 |  |  | 14 | 77.8 |  |  | 12 | 80.0 |
| Certified to teach |  | 8 | 61.5 |  |  | 14 | 70.0 |  |  | 18 | 69.2 |  |  | 19 | 100.0 |  |  | 17 | 94.4 |  |  | 15 | 100.0 |
| Head Start affiliateda |  | 1 | 8.3 |  |  | 3 | 15.8 |  |  | 6 | 23.1 |  |  |  |  |  |  |  |  |  |  |  |  |
| Public funding/schoolb |  | 2 | 16.7 |  |  | 2 | 10.5 |  |  | 4 | 15.4 |  |  | 17 | 89.5 |  |  | 17 | 94.4 |  |  | 15 | 100.0 |
| Commercial curriculac |  | 3 | 30.0 |  |  | 6 | 33.3 |  |  | 16 | 64.0 |  |  | 13 | 68.4 |  |  | 13 | 72.2 |  |  | 10 | 66.7 |
| Setting |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Urban |  | 3 | 25.0 |  |  | 8 | 40.0 |  |  | 12 | 46.2 |  |  | 6 | 31.6 |  |  | 5 | 27.8 |  |  | 4 | 28.6 |
| Suburban |  | 6 | 50.0 |  |  | 12 | 60.0 |  |  | 11 | 42.3 |  |  | 10 | 52.6 |  |  | 9 | 50.0 |  |  | 7 | 50.0 |
| Rural |  | 3 | 25.0 |  |  | 0 | 0.0 |  |  | 3 | 11.5 |  |  | 3 | 15.8 |  |  | 4 | 22.2 |  |  | 3 | 21.4 |
| Child characteristics |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Female |  | 55 | 53.9 |  |  | 60 | 51.7 |  |  | 71 | 49.7 |  |  | 59 | 50.4 |  |  | 56 | 48.7 |  |  | 46 | 47.9 |
| Race |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| White |  | 74 | 74.0 |  |  | 89 | 78.1 |  |  | 110 | 80.3 |  |  | 84 | 73.0 |  |  | 90 | 81.1 |  |  | 69 | 72.6 |
| Black |  | 16 | 16.0 |  |  | 12 | 10.5 |  |  | 15 | 10.9 |  |  | 7 | 6.1 |  |  | 9 | 8.1 |  |  | 14 | 14.7 |
| Other/Multiracial |  | 10 | 10.0 |  |  | 13 | 11.4 |  |  | 12 | 8.8 |  |  | 24 | 20.9 |  |  | 12 | 10.8 |  |  | 12 | 12.6 |
| Hispanic/Latino |  | 14 | 14.0 |  |  | 10 | 8.8 |  |  | 18 | 12.9 |  |  | 28 | 24.6 |  |  | 19 | 17.0 |  |  | 14 | 14.7 |
| Caregiver highest degree | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| HS diploma or less |  | 30 | 30.3 |  |  | 37 | 33.0 |  |  | 57 | 40.7 |  |  | 68 | 59.1 |  |  | 63 | 56.8 |  |  | 41 | 43.6 |
| Associates |  | 12 | 12.1 |  |  | 3 | 2.7 |  |  | 13 | 9.3 |  |  | 11 | 9.6 |  |  | 15 | 13.5 |  |  | 14 | 14.9 |
| Bachelors |  | 32 | 32.3 |  |  | 44 | 39.3 |  |  | 39 | 27.9 |  |  | 18 | 15.7 |  |  | 20 | 18.0 |  |  | 28 | 29.8 |
| Graduate |  | 25 | 25.2 |  |  | 28 | 25.0 |  |  | 31 | 22.1 |  |  | 18 | 15.7 |  |  | 13 | 11.7 |  |  | 11 | 11.7 |
| English as primary  home language |  | 84 | 97.7 |  |  | 87 | 94.6 |  |  | 110 | 97.3 |  |  | 77 | 87.5 |  |  | 78 | 96.3 |  |  | 70 | 95.9 |
| IEP |  | 9 | 8.9 |  |  | 7 | 6.1 |  |  | 12 | 8.6 |  |  | 4 | 3.5 |  |  | 10 | 8.8 |  |  | 3 | 3.2 |
| Annual family income |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <$40K |  | 21 | 25.3 |  |  | 16 | 17.6 |  |  | 32 | 29.4 |  |  | 32 | 38.1 |  |  | 26 | 32.9 |  |  | 23 | 32.4 |
| $40K~$85K |  | 19 | 22.9 |  |  | 25 | 27.5 |  |  | 26 | 23.9 |  |  | 23 | 27.4 |  |  | 32 | 40.5 |  |  | 23 | 32.4 |
| >85K |  | 43 | 51.8 |  |  | 50 | 54.9 |  |  | 51 | 46.8 |  |  | 29 | 34.5 |  |  | 21 | 26.6 |  |  | 25 | 35.2 |
|  | *M* | *SD* | Range |  | *M* | *SD* | Range |  | *M* | *SD* | Range |  | *M* | *SD* | Range |  | *M* | *SD* | Range |  | *M* | *SD* | Range |
| Teacher/classroom characteristics | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Age (years) | 37.85 | 10.06 | 23–60 |  | 39.47 | 9.32 | 25–57 |  | 41.92 | 10.63 | 22–60 |  | 38.37 | 9.47 | 24–57 |  | 40.11 | 10.97 | 24–59 |  | 43.14 | 9.61 | 26–58 |
| Years of experience | 13.77 | 9.80 | 1–30 |  | 10.33 | 5.51 | 1–20 |  | 14.72 | 9.02 | 2–30 |  | 12.63 | 7.19 | 3–30 |  | 12.22 | 11.69 | 2–48 |  | 16.87 | 8.26 | 4–30 |
| Class size | 15.08 | 4.06 | 10–23 |  | 16.65 | 6.80 | 10–31 |  | 15.92 | 4.99 | 9–33 |  | 21.00 | 3.70 | 11–27 |  | 19.89 | 3.69 | 12–26 |  | 19.73 | 3.65 | 13–25 |
| Child age (months) | 54.41 | 3.93 | 47–63 |  | 54.05 | 4.05 | 46–67 |  | 54.29 | 4.12 | 46–63 |  | 65.74 | 4.62 | 56–79 |  | 66.19 | 4.42 | 57–84 |  | 65.97 | 4.45 | 56–75 |
| Child language comprehension pretest scores | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| TNR: Story Grammar | 5.51 | 6.75 | 0–24 |  | 6.11 | 6.74 | 0–23 |  | 7.17 | 6.92 | 0–25 |  | 10.18 | 8.30 | 0–28 |  | 9.71 | 7.80 | 0–26 |  | 10.98 | 7.88 | 0–28 |
| TNR: Story Cohesion | 0.69 | 1.01 | 0–5 |  | 0.98 | 1.25 | 0–4 |  | 1.07 | 1.26 | 0–5 |  | 1.54 | 1.82 | 0–11 |  | 1.41 | 1.87 | 0–12 |  | 1.74 | 1.64 | 0–7 |
| TNR: Comprehension | 3.03 | 1.72 | 0–6 |  | 3.13 | 1.78 | 0–6 |  | 2.96 | 1.67 | 0–6 |  | 4.04 | 1.58 | 0–6 |  | 3.92 | 1.62 | 0–6 |  | 3.99 | 1.49 | 0–6 |
| TNL: Comprehension | 11.86 | 6.63 | 0–28 |  | 12.33 | 6.63 | 0–28 |  | 12.14 | 6.81 | 0–27 |  | 16.85 | 7.17 | 0–29 |  | 17.11 | 6.56 | 0–29 |  | 17.43 | 7.05 | 2–32 |
| Expressive Vocabulary  Testd | 63.87 | 11.21 | 25–100 |  | 64.56 | 13.83 | 36–88 |  | 61.24 | 14.76 | 19–100 |  | 68.31 | 15.62 | 31–101 |  | 70.76 | 12.82 | 36–102 |  | 72.62 | 15.66 | 21–103 |
| Let’s Know! Vocab | 2.96 | 2.68 | 0–10 |  | 4.07 | 2.97 | 0–18 |  | 2.61 | 2.93 | 0–15 |  | 3.84 | 3.35 | 0–14 |  | 3.78 | 2.97 | 0–13 |  | 2.98 | 2.95 | 0–14 |
| Child targeted comprehension-related skills | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| CAM: Vocabulary | 32.86 | 16.62 | 2–64 |  | 34.28 | 14.58 | 1–61 |  | 13.24 | 9.59 | 0–42 |  | 37.62 | 13.46 | 3–60 |  | 40.90 | 14.00 | 3–63 |  | 12.00 | 7.15 | 2–30 |
| CAM: Comprehension  Monitoring | 7.27 | 4.61 | 0–15 |  | 7.82 | 4.01 | 0–16 |  | 4.11 | 3.22 | 0–13 |  | 9.59 | 4.12 | 0–16 |  | 9.97 | 4.05 | 0–16 |  | 4.80 | 3.01 | 0–13 |
| CAM: Understanding  Narrative Text | 9.31 | 2.25 | 3–12 |  | 9.10 | 2.79 | 0–12 |  | 9.19 | 2.77 | 1–12 |  | 10.35 | 1.92 | 1–12 |  | 10.60 | 1.75 | 3–12 |  | 10.10 | 2.01 | 3–12 |
| CAM: Story Grammar | 22.15 | 12.90 | 0–45 |  | 22.36 | 13.37 | 0–45 |  | 20.46 | 12.40 | 0–46 |  | 28.84 | 13.09 | 0–60 |  | 28.95 | 12.99 | 0–55 |  | 27.61 | 12.81 | 0–51 |
| CAM: Understanding  Expository Text | 2.34 | 1.97 | 0–7 |  | 2.42 | 1.65 | 0–7 |  | 1.68 | 1.21 | 0–6 |  | 3.73 | 1.77 | 0–8 |  | 3.51 | 1.87 | 0–7 |  | 3.16 | 1.61 | 0–7 |
| Child language comprehension outcomes | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| TNR: Story Grammar | 11.70 | 7.68 | 0–24 |  | 13.01 | 7.81 | 0–26 |  | 13.05 | 7.33 | 0–26 |  | 16.64 | 7.40 | 0–30 |  | 18.16 | 7.60 | 0–33 |  | 17.31 | 7.98 | 0–32 |
| TNR: Story Cohesion | 1.53 | 1.47 | 0–5 |  | 1.69 | 1.47 | 0–5 |  | 1.63 | 1.45 | 0–6 |  | 2.40 | 1.89 | 0–7 |  | 2.84 | 2.09 | 0–11 |  | 2.66 | 2.15 | 0–11 |
| TNR: Comprehension | 3.68 | 1.78 | 0–6 |  | 3.98 | 1.59 | 0–6 |  | 4.14 | 1.67 | 0–6 |  | 4.39 | 1.40 | 0–6 |  | 4.11 | 1.45 | 1–6 |  | 4.69 | 1.24 | 1–6 |
| TNL: Comprehension | 17.52 | 7.02 | 2–30 |  | 18.90 | 6.55 | 3–32 |  | 17.66 | 7.08 | 1–31 |  | 22.54 | 6.50 | 2–34 |  | 22.08 | 6.30 | 4–34 |  | 22.99 | 5.80 | 3–33 |
| Let’s Know! Vocab | 10.81 | 7.25 | 0–31 |  | 12.39 | 7.13 | 0–28 |  | 5.87 | 4.54 | 0–19 |  | 13.43 | 6.89 | 0–26 |  | 15.44 | 6.30 | 1–29 |  | 6.62 | 4.05 | 0–20 |

*Note.* Numbers reflect the analytic sample. HS = high school; IEP = individualized education plan; TNR = Test of Narrative Retell (Petersen & Spencer, 2012); TNL = Test of Narrative Language (Gillam & Pearson, 2004); Vocab = vocabulary; CAM = curriculum-aligned measure.

aRelevant to prekindergarten sample only. bClassroom associated with publicly funded prekindergarten program for prekindergarten sample or within a public school (as opposed to private or parochial) for the kindergarten sample. cTeacher reported using a commercially available curriculum in the classroom. dExpressive Vocabulary Test (Williams, 1997-2007) administered at pretest only.

## Table 2

Results of Multilevel Analyses Estimating Pairwise Comparisons on Targeted Comprehension-related Skills and Language Comprehension Outcomes in the Prekindergarten Sample

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Let’s Know! Broad v. Control | | | |  | Let’s Know! Deep v. Control | | | |  | Let’s Know! Deep v. Broad | | | |
| Measure | ICC | Coef | *z* | *pa* | *d* |  | Coef | *z* | *pa* | *d* |  | Coef | *z* | *pa* | *d* |
| Targeted comprehension-related skills | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| CAM: Vocabulary | .64 | 15.37 | 5.43 | **<.001** | **0.90** |  | 20.85 | 10.28 | **<.001** | **1.22** |  | 5.48 | 1.74 | .830 | 0.32 |
| CAM: Comprehension  Monitoring | .43 | 2.28 | 3.31 | **.003** | **0.55** |  | 3.23 | 5.26 | **<.001** | **0.77** |  | 0.94 | 1.16 | .987 | 0.23 |
| CAM: Understanding Narrative  Text | .23 | -0.10 | -0.25 | .855 | -0.04 |  | -0.11 | -0.24 | .897 | -0.04 |  | -0.01 | -0.02 | .987 | 0.00 |
| CAM: Story Grammar | .17 | 1.28 | 0.73 | .780 | 0.10 |  | 1.14 | 0.65 | .737 | 0.09 |  | -0.14 | -0.07 | .987 | -0.01 |
| CAM: Understanding  Expository Text | .32 | 0.66 | 1.91 | .140 | 0.42 |  | 0.78 | 3.22 | **.003** | **0.49** |  | 0.12 | 0.33 | .987 | 0.08 |
| Language comprehension outcomes | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| TNR: Story Grammar | .05 | -0.18 | -0.18 | .855 | -0.02 |  | -0.04 | -0.05 | .963 | -0.01 |  | 0.39 | 0.41 | .987 | 0.05 |
| TNR: Story Cohesion | .00 | 0.04 | 0.22 | .855 | 0.03 |  | 0.06 | 0.32 | .897 | 0.04 |  | 0.02 | 0.11 | .987 | 0.01 |
| TNR: Comprehension | .24 | -0.40 | -1.40 | .328 | -0.24 |  | -0.24 | -1.03 | .505 | -0.15 |  | 0.16 | 0.52 | .987 | 0.10 |
| TNL: Comprehension | .22 | 0.23 | 0.40 | .855 | 0.03 |  | 0.91 | 1.31 | .384 | 0.13 |  | 0.68 | 0.93 | .987 | 0.10 |
| Let’s Know! Vocabulary | .44 | 4.69 | 4.59 | **<.001** | **0.69** |  | 5.03 | 6.70 | **<.001** | **0.74** |  | 0.35 | 0.30 | .987 | 0.05 |

*Note.* Model estimates are combined over 20 imputed datasets. Significant comparisons (*p* < .05) are **bolded**. Covariates are not listed but were included in statistical models. For measures of targeted comprehension-related skills, covariates included pretest Let’s Know! Vocabulary scores, pretest TNR story cohesion scores, cohort, and site. For language comprehension outcomes, covariates included the pretest score on the relevant outcome, Let’s Know! Vocabulary scores, pretest TNR story cohesion scores, cohort, and site. ICC = intraclass correlation from unconditional model; Coef = unstandardized regression coefficient; *z* = ratio of parameter estimate to standard error; *d* = effect size computed using , in which *B* represents the unstandardized regression coefficient, and τ00 and σ2 represent the level-2 variance component and level-1 residuals, respectively, from the unconditional model; CAM = curriculum-aligned measure; TNR = Test of Narrative Retell; TNL = Test of Narrative Language.

*a*Benjamini-Hochberg corrected *p*-values

**Table 3**

*Results of Multilevel Analyses Estimating Pairwise Comparisons on Targeted Comprehension-related Skills and Language Comprehension Outcomes in the Kindergarten Sample*

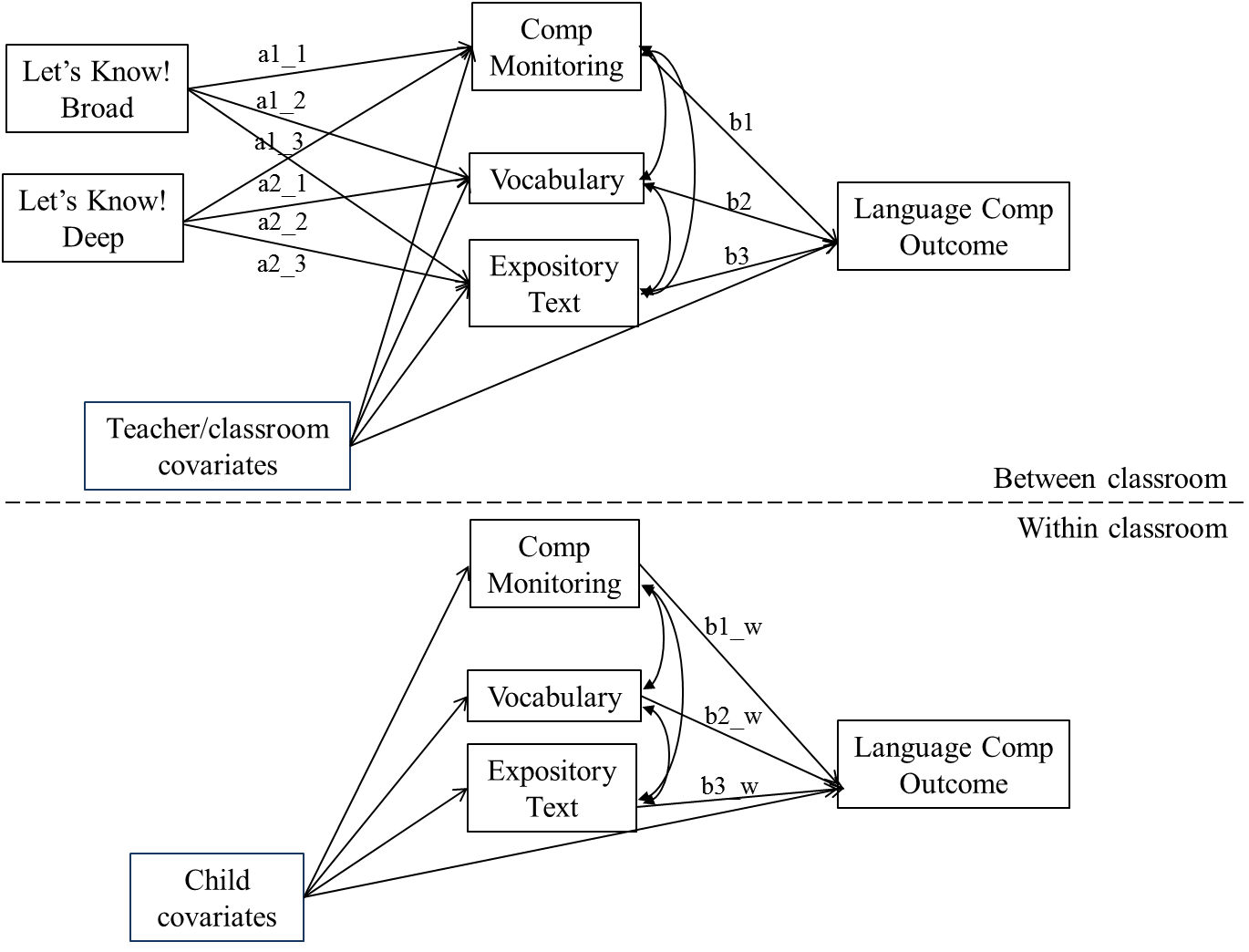
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Let’s Know! Broad v. Control | | | |  | Let’s Know! Deep v. Control | | | |  | Let’s Know! Deep v. Broad | | | |
| Measure | ICC | Coef | *z* | *pa* | *d* |  | Coef | *z* | *pa* | *d* |  | Coef | *z* | *pa* | *d* |
| Targeted comprehension-related skills | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| CAM: Vocabulary | 0.62 | 22.75 | 9.85 | **<.001** | **1.33** |  | 26.60 | 10.42 | **<.001** | **1.55** |  | 3.85 | 1.44 | .375 | 0.22 |
| CAM: Comprehension  Monitoring | 0.37 | 4.32 | 6.15 | **<.001** | **1.01** |  | 4.51 | 6.00 | **<.001** | **1.05** |  | 0.19 | 0.26 | .796 | 0.04 |
| CAM: Understanding Narrative  Text | 0.15 | -0.11 | -0.28 | .885 | -0.06 |  | 0.30 | 0.84 | .447 | 0.16 |  | 0.41 | 1.12 | .526 | 0.22 |
| CAM: Story Grammar | 0.10 | 0.42 | 0.21 | .885 | 0.03 |  | 0.88 | 0.51 | .612 | 0.07 |  | 0.45b | 0.26 | .796 | 0.03 |
| CAM: Understanding  Expository Text | 0.19 | 0.60 | 1.99 | **.**115 | 0.34 |  | 0.37 | 1.30 | .320 | 0.21 |  | -0.22 | -0.73 | .586 | -0.13 |
| Language comprehension outcomes | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| TNR: Story Grammarc | 0.08 | 0.15 | 0.15 | .885 | 0.02 |  | 1.77 | 1.88 | .120 | 0.26 |  | 1.63 | 1.83 | .227 | 0.24 |
| TNR: Story Cohesiond | 0.11 | -0.06 | -0.45 | .885 | 0.94d |  | 0.15 | 1.10 | .338 | 1.16d |  | 0.21 | 1.88 | .227 | 1.23d |
| TNR: Comprehension | 0.16 | -0.35 | -1.42 | .310 | -0.25 |  | -0.54 | -2.53 | **.028** | **-0.39** |  | -0.18 | -0.75 | .586 | -0.13 |
| TNL: Comprehension | 0.20 | -0.30 | -0.43 | .885 | -0.05 |  | -0.80 | -1.14 | .338 | -0.13 |  | -0.49 | -0.72 | .586 | -0.08 |
| Let’s Know! Vocabulary | 0.48 | 5.30 | 5.43 | **<.001** | **0.76** |  | 7.83 | 10.64 | **<.001** | **1.12** |  | 2.54 | 2.36 | .180 | 0.36 |

*Note.* Model estimates are combined over 20 imputed datasets. Significant comparisons (*p* < .05) are **bolded**. Covariates are not listed but were included in statistical models. For measures of targeted comprehension-related skills, covariates included whether children had English as their primary home language, cohort, and site. For language comprehension outcomes, covariates included the pretest score on the relevant outcome, whether children had English as their primary home language, cohort, and site. ICC = intraclass correlation from unconditional model; Coef = unstandardized regression coefficient; *z* = ratio of parameter estimate to standard error; *d* = effect size computed using , in which *B* represents the unstandardized regression coefficient, and τ00 and σ2 represent the level-2 variance component and level-1 residuals, respectively, from the unconditional model; CAM = curriculum-aligned measure; TNR = Test of Narrative Retell; TNL = Test of Narrative Language.

*a*Benjamini-Hochberg corrected *p*-values. bModel failed to converge for one of the 20 imputed datasets even with adjusted criteria. cEstimated using a two-part model, with treatment effects only modeled for the continuous part in level-2 (the variance component was not significantly different from zero for the binary part and adding predictors for the binary part caused estimation issues); ICC based on the unconditional multilevel model). dEstimated using negative binomial model given distribution. dIncidence rate ratio = exp(Coef).

**Figure 1**

*Results of Multilevel Path Model Testing Indirect Effects of Let’s Know! on Language Comprehension Outcomes in the Prekindergarten Sample*

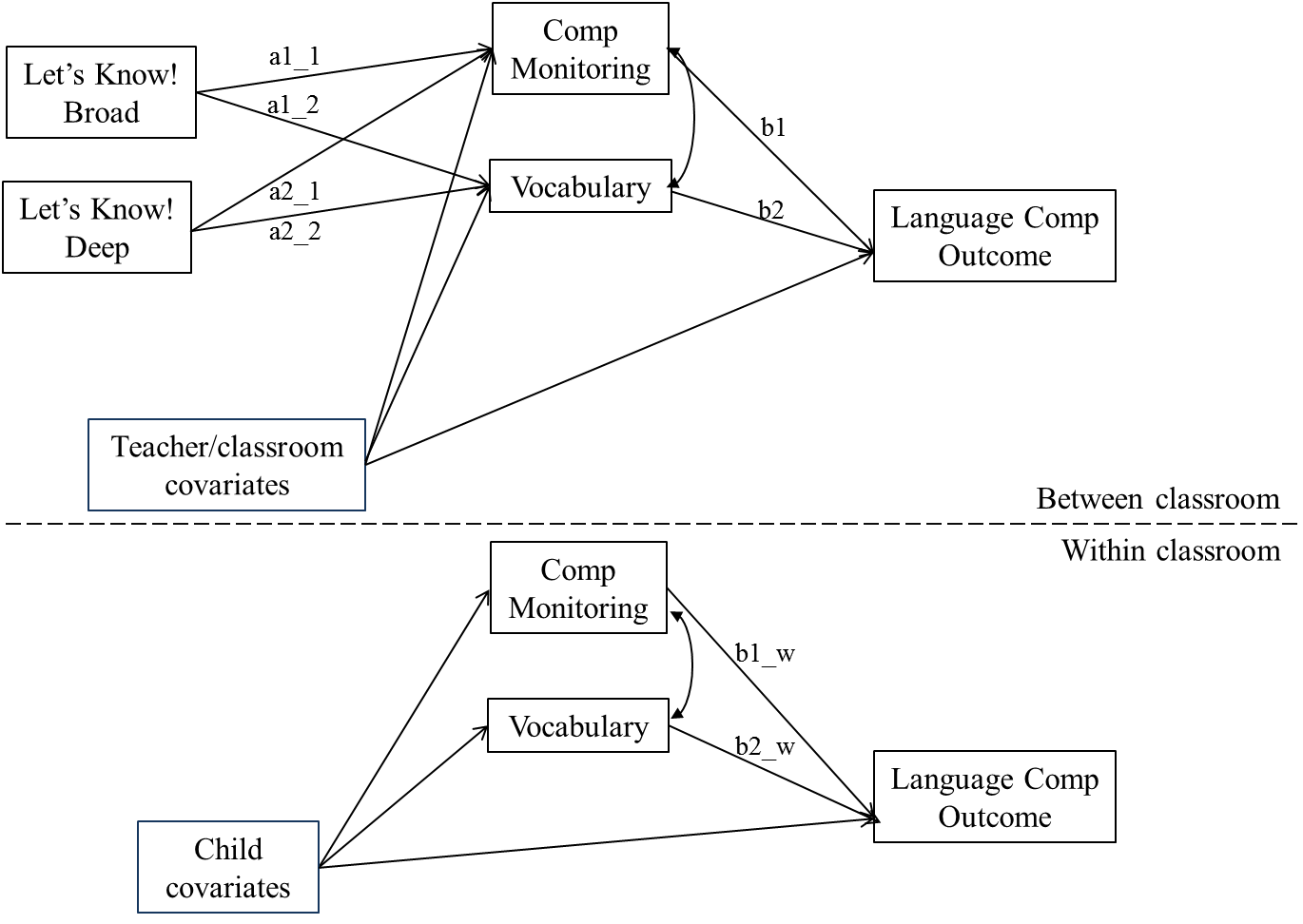


|  | TNR: Comprehension | | |  | TNL: Comprehension | | |  | Let’s Know! Vocabulary | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Model estimate | Coef | *z* | *p* |  | Coef | *z* | *p* |  | Coef | *z* | *p* |
| Within level |  |  |  |  |  |  |  |  |  |  |  |
| b1\_w | 0.09 | 2.51 | .012 |  | 0.22 | 2.18 | .029 |  | 0.05 | 0.53 | .594 |
| b2\_w | 0.03 | 2.40 | .016 |  | 0.10 | 2.95 | .003 |  | 0.27 | 8.01 | <.001 |
| b3\_w | -0.07 | -1.08 | .282 |  | 0.30 | 1.56 | .118 |  | -0.09 | -0.48 | .631 |
| Between level |  |  |  |  |  |  |  |  |  |  |  |
| b1 | -0.01 | -0.06 | .954 |  | 0.42 | 1.28 | .199 |  | -0.00 | -0.01 | .995 |
| b2 | -0.00 | -0.06 | .956 |  | -0.05 | -0.83 | .406 |  | 0.31 | 3.81 | <.001 |
| b3 | -0.06 | -0.29 | .771 |  | 0.64 | 1.45 | .149 |  | -1.18 | -2.19 | .028 |
| a1\_1 | 2.40 | 3.45 | .001 |  | 2.38 | 3.50 | <.001 |  | 2.25 | 3.14 | .002 |
| a1\_2 | 15.70 | 5.59 | <.001 |  | 15.90 | 5.69 | <.001 |  | 15.32 | 5.38 | <.001 |
| a1\_3 | 0.69 | 1.98 | .048 |  | 0.66 | 1.92 | .055 |  | 0.60 | 1.74 | .082 |
| a2\_1 | 3.34 | 5.60 | <.001 |  | 3.47 | 5.82 | <.001 |  | 3.26 | 5.26 | <.001 |
| a2\_2 | 21.10 | 10.70 | <.001 |  | 21.62 | 11.79 | <.001 |  | 20.77 | 10.21 | <.001 |
| a2\_3 | 0.77 | 3.20 | .001 |  | 0.79 | 3.28 | .001 |  | 0.81 | 3.37 | .001 |
| Indirect effects | |  |  |  |  |  |  |  |  |  |  |
| a1\_1\*b1 | -0.03 | -0.08 | .935 |  | 0.99 | 1.33 | .182 |  | 0.02 | 0.02 | .985 |
| a2\_1\*b1 | -0.03 | -0.06 | .949 |  | 1.47 | 1.24 | .214 |  | -0.02 | -0.01 | .989 |
| a1\_2\*b2 | -0.03 | -0.05 | .958 |  | -0.88 | -0.83 | .406 |  | 4.69 | 2.91 | **.004** |
| a2\_2\*b2 | -0.04 | -0.06 | .955 |  | -1.19 | -0.83 | .409 |  | 6.35 | 3.64 | **<.001** |
| a1\_3\*b3 | -0.04 | -0.27 | .785 |  | 0.41 | 1.23 | .209 |  | -0.70 | -1.74 | .082 |
| a2\_3\*b3 | -0.04 | -0.28 | .780 |  | 0.50 | 1.33 | .185 |  | -0.96 | -1.73 | .084 |

*Note*. Estimates combined over 20 imputed datasets. Significant indirect effects (*p* < .05) are bolded. Covariates are not depicted but were included in statistical models. For measures of targeted comprehension-related skills, covariates included pretest Let’s Know! Vocabulary scores, pretest TNR story cohesion scores, cohort, and site. For language comprehension outcomes, covariates included the pretest score on the relevant outcome, Let’s Know! Vocabulary scores, pretest TNR story cohesion scores, cohort, and site. Comp = comprehension; Expository Text = Understanding Expository Text; TNR = Test of Narrative Retell; TNL = Test of Narrative Language; Coef = unstandardized regression coefficient; *z* = ratio of parameter estimate to standard error.

**Figure 2**

*Results of Multilevel Path Model Testing Indirect Effects of Let’s Know! on Language Comprehension Outcomes in the Kindergarten Sample*



|  | TNR:  Story Cohesion | | |  | TNR: Comprehension | | |  | TNL: Comprehension | | |  | Let’s Know! Vocabulary | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Model estimate | Coef | *z* | *p* |  | Coef | *z* | *p* |  | Coef | *z* | *p* |  | Coef | *z* | *p* |
| Within level |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b1\_w | 0.04 | 2.06 | .039 |  | 0.06 | 1.85 | .064 |  | 0.29 | 3.28 | .001 |  | 0.19 | 2.66 | .008 |
| b2\_w | 0.01 | 1.17 | .241 |  | 0.03 | 3.95 | <.001 |  | 0.13 | 4.84 | <.000 |  | 0.29 | 9.33 | <.001 |
| Between level |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b1 | -0.03 | -0.33 | .740 |  | -0.10 | -0.88 | .381 |  | -0.40 | -1.00 | .316 |  | -0.82 | -1.63 | .104 |
| b2 | -0.01 | -0.30 | .764 |  | 0.00 | 0.03 | .977 |  | 0.06 | 0.86 | .391 |  | 0.42 | 4.53 | <.001 |
| a1\_1 | 4.47 | 6.39 | <.001 |  | 4.22 | 6.09 | <.001 |  | 4.42 | 6.93 | <.001 |  | 3.90 | 5.71 | <.001 |
| a1\_2 | 23.29 | 10.60 | <.001 |  | 22.49 | 10.11 | <.001 |  | 23.13 | 11.76 | <.001 |  | 20.91 | 9.26 | <.001 |
| a2\_1 | 4.58 | 5.60 | <.001 |  | 4.64 | 6.43 | <.001 |  | 4.61 | 6.80 | <.001 |  | 3.74 | 4.68 | <.001 |
| a2\_2 | 26.96 | 10.44 | <.001 |  | 27.06 | 11.15 | <.001 |  | 26.72 | 10.86 | <.001 |  | 24.48 | 9.09 | <.001 |
| Indirect effects | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a1\_1\*b1 | -0.13 | -0.34 | .736 |  | -0.42 | -0.90 | .368 |  | -1.74 | -1.04 | .298 |  | -3.20 | -1.57 | .117 |
| a2\_1\*b1 | -0.13 | -0.33 | .745 |  | -0.46 | -0.87 | .384 |  | -1.83 | -0.97 | .331 |  | -3.05 | -1.71 | .087 |
| a1\_2\*b2 | -0.11 | -0.30 | .767 |  | 0.01 | 0.03 | .977 |  | 1.44 | 0.86 | .389 |  | 8.69 | 4.42 | **<.001** |
| a2\_2\*b2 | -0.13 | -0.30 | .764 |  | 0.02 | 0.03 | .977 |  | 1.67 | 0.85 | .396 |  | 10.17 | 4.42 | **<.001** |

*Note*. Estimates combined over 20 imputed datasets. Significant indirect effects (*p* < .05) are bolded. Covariates are not depicted but were included in statistical models. For targeted comprehension-related skills, covariates included whether children had English as their primary home language, cohort, and site. For language comprehension outcomes, covariates included the pretest score on the relevant outcome, whether children had English as their primary home language, cohort, and site. Comp = comprehension; TNR = Test of Narrative Retell; TNL = Test of Narrative Language; Coef = unstandardized regression coefficient; *z* = ratio of parameter estimate to standard error.