IMPROVING LOW-INCOME PRESCHOOLERS' WORD AND WORLD KNOWLEDGE

The Effects of Content-Rich Instruction

Susan B. Neuman
NEW YORK UNIVERSITY

Tanya Kaefer
LAKEHEAD UNIVERSITY, CANADA

Ashley M. Pinkham
WEST TEXAS A & M UNIVERSITY

ABSTRACT
This study examined the efficacy of a shared book-reading approach to integrating literacy and science instruction. The purpose was to determine whether teaching science vocabulary using information text could improve low-income preschoolers' word knowledge, conceptual development, and content knowledge in the life sciences. Teachers in 17 preschool classrooms and 268 children participated; nine classrooms were assigned to treatment, eight to control. The treatment group received a science-focused shared book-reading intervention, 4 days a week, 12–15 minutes daily for 12 weeks, while the control group continued with business as usual. Results indicated statistically and practically significant effects on children's word, concepts, and content knowledge and knowledge of the information text genre compared to the control group. However, we recognize the potential confound of district with treatment condition as a major limitation of the study.

THE ELEMENTARY SCHOOL JOURNAL
Volume 116, Number 4. Published online May 17, 2016

It is widely acknowledged that robust vocabulary instruction for preschoolers occurs most effectively in meaningful contexts with many opportunities for active engagement and rich conversations (Beck & McKeown, 2007). For these exchanges to be effectual, however, young children need a threshold level of knowledge about the topic in order to make constructive use of the new vocabulary they are learning (Hirsch, 2003). Consequently, word and world knowledge are reciprocal, mutually reinforcing processes related to gains in conceptual development and comprehension (Neuman, Newman, & Dwyer, 2011).

There is a growing recognition among educators that the genre of the text can also help to scaffold these processes (Cervetti & Barber, 2008; Neuman, 1996). Studies (Price, Bradley, & Smith, 2012; Price, van Kleeck, & Huberty, 2009) have shown that genre affects the type of talk that occurs between adults and preschool children. Narrative texts, for example, tend to support conversations about characters and their traits, whereas information or expository texts encourage descriptions of the attributes of a topic (Price et al., 2009). Similarly, different genres tend to support different types of vocabulary. Narrative texts are more likely to use words that reflect mental states (e.g., *think, know*) and temporal connections (e.g., *before, after*), while information books tend to use more academic language (e.g., *predict, observe*) and conceptually dense words (e.g., *investigation*) (Pappas, 1991). In short, children's vocabulary, conceptual knowledge, and comprehension of text may be shaped by genre; their knowledge and comfort with different text structures may, in turn, contribute to their growing word knowledge and conceptual base (Cervetti, Barber, Dorph, Pearson, & Goldschmidt, 2012).

Recent studies have therefore investigated more deliberate efforts to integrate literacy skills and content knowledge using multiple genres in shared book-reading programs for preschoolers. Recognizing that young children are capable of acquiring a rich knowledge base that supports vocabulary development, French (2004) created a thematically organized shared book-reading program around science content, specifically using narrative and information text to promote vocabulary and higher-order skills, such as planning, predicting, and problem solving. Known as ScienceStart!, teachers engaged children in explorations and play about a topic, large-group book readings, and other activities designed to promote scientific reasoning. Following the 10-week intervention, Head Start children learned the science concepts taught throughout the program; furthermore, the researchers reported significant gains of approximately .5 standard deviations on a standardized measure of receptive language (i.e., Peabody Picture Vocabulary Test [PPVT]). Despite lacking in experimental controls, this study provides a plausible case for the synergy between vocabulary development and content instruction.

Targeting content-related word learning in particular, Leung (2008) also explored the effects of a shared-information book-reading program to support science-related vocabulary development for preschoolers from varied socioeconomic (SES) backgrounds. In this program, children were exposed to repeated readings of science texts and thematically related hands-on activities. Following the reading, half of the sample was randomly assigned to retell the text; the other half were not asked to retell. Results of the study indicated that retelling appeared to substantially enhance children's science-related vocabulary gains (i.e., Cohen's $d = 2.90$), and repeated reading of information texts may have increased children's ability to explain the meanings of target science words. Although the sample size was small (i.e., $n = 16$ per condition), the study illuminates the potential of using repeated readings of information text for developing domain-specific vocabulary knowledge.

Building on these previous studies, Gonzalez and his colleagues (Gonzalez et al., 2011) examined the efficacy of a shared book-reading science and social studies intervention designed to improve preschoolers' general and content-specific vocabulary development. Teachers in the intervention group engaged children in daily shared book reading. They taught target words explicitly, and used repeated readings and knowledge-building supports to facilitate frequent encounters with words and deeper processing of vocabulary knowledge. Multilevel analyses indicated statistically and practically significant effects of the intervention on researcher-developed, domain-specific measures of expressive and receptive vocabulary (i.e., Cohen's $d = 1.01$ and 1.41, respectively), as well as standardized measures of receptive vocabulary (i.e., Cohen's $d = .93$).

Together, these studies provide substantial evidence that young children are highly capable of acquiring content-specific words, and that teachers' purposeful selection and teaching of target vocabulary may intensify instruction within shared book reading. However, relatively little is known about the effects of such programs on developing children's content knowledge, specifically, their ability to acquire and understand critical concepts in the target domain. Part of the reason for this discrepancy may be a difficulty of empirically isolating and defining conceptual knowledge. Broadly considered, concepts are organized mental representations (Gelman, 2009), which often correspond to taxonomic categories (Margolis, 1994). Importantly, these mental representations can encompass people, things, states, events, properties, and abstract ideas (Medin, Lynch, & Solomon, 2000). In this way, concepts are nested (Gelman, 1996). For example, the concept of insect as having "three body parts and six legs" is embedded within the broader concept of living things, and uses the attributes of "six legs" and "three body parts" as definitional properties. Although this conceptual overlap is absolutely essential for building the interrelated knowledge networks that serve as the foundation for learning and cognitive development (Kaefer, Neuman, & Pinkham, 2014; Rehder & Hastie, 2004), it makes the process of isolating children's conceptual knowledge development for research purposes particularly challenging. Nevertheless, concepts are generally understood to be the building blocks of ideas (Gelman & Kalish, 2005).

Similarly, because of this overlap, domain-specific vocabulary may be central to the development of knowledge networks made up of clusters of concepts that are coherent, generative, and supportive of future learning in the domain (Clements, 2007). Many studies (e.g., Elleman, Lindo, Morphy, & Compton, 2009) have shown that vocabulary training may positively impact children's comprehension; however, little attention has been paid to whether vocabulary training may also enhance their knowledge base. Although we may assume that young children may be acquiring knowledge, to date there is little evidence to substantiate this claim.

Furthermore, it is conceivable that interventions supporting greater use of information books may also enable children to acquire an understanding of the characteristics of the genre. Information books often contain specific features that convey more technical, scientific kinds of information (Duke & Billman, 2009). Such visual design features might include picture glossaries, scale diagrams revealing relationships among ideas within the topic, and illustration extensions, such as labeling, captions, and dialogue bubbles, that aid in the interpretation of text (Pappas, 1991). Previous shared book-reading interventions (e.g., Leung, 2008), however, have tended to restrict their focus to vocabulary learning, ignoring a potentially serendipitous effect: exposure to such genre features could additionally provide preschool children with techniques for better comprehending information text.

Studies that integrate word and world knowledge and use genre features to their advantage have taken on a special urgency with the adoption of the Common Core State Standards (Neuman & Wright, 2013). By the end of kindergarten, children are expected to possess the academic language associated with information text and be able to acquire knowledge through these texts (Common Core State Standards Initiative, 2010). According to reports by the National Assessment of Educational Progress (National Center for Education Statistics, 2011), over one-third of children fail to read at basic levels by fourth grade, and the percentage is even higher for children who live in poverty or come from marginalized ethnic and linguistic communities. It becomes incumbent for educators and researchers to develop more intensive and intentional opportunities for children to integrate their vocabulary and content knowledge. Studies (e.g., Cunningham & Stanovich, 1991; Mol & Bus, 2011; Neuman & Celano, 2012) have documented wide disparities in access to print and vocabulary beginning early in children's lives, and the negative associations between limited vocabulary development and the long-term trajectory for comprehension and reading performance (Cunningham & Stanovich, 1997). Furthermore, studies have shown a Matthew Effect (Stanovich, 1986), or spiraling of disadvantage or advantage, such that students who come to school with limited vocabulary knowledge learn less new vocabulary and participate in fewer cognitively rich instructional opportunities than their more average peers.

To this end, the current study was designed to address the simultaneous goals of improving children's vocabulary and concept knowledge. Because of the overlapping nature of concepts and for the purposes of clarity, we use the term "concept" to refer primarily to the taxonomic categories and exemplars of those categories that serve as our topics of instruction. Since concepts also include properties, we refer to the attributes of these concepts as "categorical properties." Finally, we use the term "core themes" to refer to the broader conceptual information that applies across all of the concepts we teach. In this respect, we examine the nested nature of concepts, the vocabulary and categorical properties within specific concepts, and the connection of these concepts to the broader knowledge structure of core themes.

This study was designed to investigate the efficacy of integrating vocabulary instruction and a content-rich shared book-reading intervention focusing on the life sciences, a set of topics closely aligned with the Next Generation Science Standards (Achieve, 2013). We hypothesized that placing special emphasis on building crucial connections between vocabulary and domain-specific knowledge using information text might improve preschoolers' word learning, concept knowledge, and comprehension of core themes. At the same time, these connections may also enable children to develop their knowledge of the genre features of information text.

Consequently, we addressed the following research questions: (1) What is the effect of a science-focused shared book-reading intervention on children's word and concept knowledge? Are there differential effects based on children's initial receptive language abilities? (2) To what extent does the intervention positively affect children's knowledge of core themes in the life sciences? (3) To what extent do children acquire greater knowledge of the genre characteristics of information text as a result of the intervention?

Method

Participants

Seventeen preschool classrooms from a state-sponsored program were recruited to participate in the study. The state program provides tuition-free preschool for at-risk 4- to 5-year-olds, identified across a spectrum of 22 risk factors (e.g., income, environmental factors, low parental educational attainment). Classrooms in this study were located in four sites representing two community-based school districts in a severely economically depressed urban fringe area in the rust-belt region of the United States that reported over 10% unemployment. One of the school districts clustered all preschool programs for the community within one site, including Head Start, family engagement programs, and early childhood special education classes (none of which were included in this study). The other, neighboring community-based district placed their preschool programs across three school sites. In both districts, each of the state-based preschool classrooms agreed to participate in the study; nine, located within one site, were assigned to treatment, and eight, representing all of the state-based preschool classrooms in the three school sites, were assigned to the control condition.

Classrooms enrolled an average of 16–19 4- and 5-year-old children for a 3.5-hour session, 4 days per week. There was a lead teacher and a full-time paraprofessional aide in each classroom; all teachers were female. Teachers had at least their B.A. degree and an early childhood state certification; paraprofessionals had their associate degrees. All teachers had considerable teaching experience in preschool (*mdn* = 11–15 years). As shown in Table 1, there were no significant dif-

Table 1. Demographic Characteristics of Treatment and Control Teachers

	Treatment	Control
Education (%):		
B.A.	40.0	14.3
M.Ed./M.A.	60.0	85.7
Early childhood endorsement (%)	100	100
Gender (%):		
Female	100	100
No. of years teaching (*mdn*)	11–15	>20
Ethnicity (%):		
Caucasian	100	63
Hispanic/Latino	–	14
Multiracial	–	23

ferences between groups in teachers' education, $\chi^2(1, N = 17) = 1.029$, $p = .310$; years of teaching experience, $\chi^2(3, N = 17) = 1.92$, $p = .589$; or ethnicity, $\chi^2(3, N = 17) = 4.10$, $p = .129$.

The initial sample included 289 children at the beginning of the study. Due to mobility, extended absenteeism (i.e., 10 days or more; 19 children), or refusal to participate in assessments (two children), the final sample included 268 children (52% boys), representing an attrition rate of 9%. Table 2 describes the demographics of the sample. Children were an average age of 4.66 years ($SD = .32$). There were no significant differences between groups in children's gender, $\chi^2(1, N = 268) = .43$, $p = .510$; native language, $\chi^2(1, N = 268) = .00$, $p = .983$; or parents' education. However, there was a significant difference in the minority status of students between the two groups, $\chi^2(1, N = 268) = 7.40$, $p = .007$. Children in the control group were significantly more ethnically diverse than children in the treatment group, $\chi^2(5, N = 268) = 20.09$, $p = .001$.

In contrast to our previous studies of low-income children from these communities (Neuman & Dwyer, 2011; Neuman et al., 2011), the Peabody Picture Vocabulary Test–IV scores (PPVT-IV; Dunn & Dunn, 2007), a measure of their receptive language, were consistent with national norms (i.e., 100), with an average standard score of 100.57 ($SD = 12.98$) for children in the treatment group and 99.33 ($SD = 13.28$) for children in the control group. Scores did not differ significantly between

Table 2. Demographic Characteristics of Treatment and Control Children

	Treatment ($n = 134$)	Control ($n = 134$)
Age (in months)	55.57 (3.34)	56.31 (4.34)
Gender (%):		
Male	53.0	51.5
Female	47.0	48.5
English as primary language (%)	97.0	97.0
Minority status** (%)	26.1	35.8
Ethnicity:*** (%)		
Caucasian	73.9	64.2
African-American	14.9	28.4
Asian	3.7	2.2
Middle Eastern	3.7	1.5
Hispanic/Latino	1.5	2.2
Multiracial	2.2	1.5
Parents' education (%):		
Completed some high school	1.0	2.2
High school diploma	42.5	48.4
Some college	14.5	14.5
Associate's degree	22.7	18.5
Bachelor's degree	15.0	12.7
Master's degree	4.2	1.5
Other (e.g., technical certificate)	0	2.2
Free or reduced lunch (school district) (%)	63.4	66.5
PPVT pretest (standard score)	100.57 (12.98)	99.33 (13.28)

Note.—PPVT = Peabody Picture Vocabulary Test–IV (Dunn & Dunn, 2007).
* $p < .05$.
** $p < .01$.
*** $p < .001$.

groups, $t(273) = .931$, $p = .350$. These average baseline scores, in comparison to the lower scores reported in our previous studies, most likely reflected the criteria for selection in targeted programs for low-income children. Eligibility in the state program was reserved for children whose family income was over the Head Start income guideline, yet were unable to access many services and necessities associated with children's health, development, and learning.

All classrooms in the state preschool program were required to use a state-approved curriculum. Both districts used High/Scope (Hohmann & Weikart, 1995), a play-based curriculum that focuses on active learning in eight domains (i.e., approaches to learning, social/emotional development, math, social studies, language and literacy, science, creative arts, physical education). In the curriculum, learning is assessed using 58 key developmental indicators that identify an observable child behavior reflecting knowledge and skills in those areas.

Instructional Intervention

Our instructional intervention included four 2-week topics from the World of Words (WOW) embedded multimedia curriculum (Neuman, Dwyer, Koh, & Wright, 2007), a supplemental intervention to support vocabulary instruction and conceptual knowledge development for low-income pre-K children. In our intervention, vocabulary words are introduced first through video clips, then through information books and picture cards, allowing children to develop an understanding of these words in multiple contexts. The curriculum is organized by topics representing concepts (e.g., insects) with specific categorical properties identified for each topic (e.g., insects have three segments and six legs). In this study, we focused on four topics related to living things (i.e., human body, marine mammals, insects, plants). Within these topics, we work toward helping children acquire conceptual knowledge of the natural world, aligned with the science standards in the Head Start Outcome Framework (U.S. Department of Health and Human Services, 2010), and a set of core themes about living things, representing one of the conceptual shifts in the Next Generation Science Standards (NGSS Lead States, 2013).

We used two databases of children's early language development to calibrate the level of difficulty of words in the curriculum (Neuman & Dwyer, 2011): the MacArthur-Bates Communicative Developmental Inventories (MCDI; Dale & Fenson, 1996) and a collection of recordings of child-adult interactions from the Child Language Data Exchange System (CHILDES; MacWhinney, 2000). The MCDI database is a set of parent-report inventories of child language and communication designed to yield information on the course of language development within a population. The MCDI has strong concurrent and predictive associations with other measures of vocabulary, language, and cognitive development (Dale & Fenson, 1996). We also used a set of corpora from CHILDES, a database consisting of transcripts of adult-child spoken interactions in a variety of home and laboratory settings. We selected a combination of English-American corpora including young children 5 years of age and under from a variety of socioeconomic backgrounds, ranging from high-risk families to professional families. From these corpora, we created a norming database to examine word frequency within and across transcripts.

Within our curriculum, words are selected in four types. The first reflects key exemplars of the taxonomic category we use to reflect selected concepts (in this case, insects); for example, *ant, katydid, bee* are types of insects. The second are words that reflect categorical properties of the concept, such as *antennae, segments, thorax, protect*, and *cooperate*, reflecting both Tier 2 (e.g., words found across a variety of domains) and Tier 3 (e.g., domain-specific), according to Beck, McKeown, and Kucan's vocabulary heuristic (2002). These two types of words are the target of instruction for each topic (approximately 15–20 words over 2 weeks). The third focuses on a sampling of out-of-concept words (e.g., *lizard, snail)* used throughout the lessons to help children clarify the concept definition, and what goes in and out of a category reflecting that concept. The fourth includes puzzlers, words that might or might not be related to the concept, designed to challenge children to think about the concept beyond the immediate lesson.

In efforts to better integrate vocabulary and concept knowledge, we also reviewed national standards for science education, as well as a recent National Research Council (2007) report highlighting the inquiry skills and learning progressions necessary for children to become proficient in science. These documents recommend learning opportunities that capitalize on children's natural interest in learning about their world, starting with the life sciences (e.g., characteristics of living organisms, life cycles, and habitats). From this review, we established core themes that could weave throughout our four key topics: basic needs of living organisms, life cycles (i.e., growth and development), protection and survival, and environment and habitats. For example, within the "insect" topic, children would engage in using the vocabulary and core themes associated with learning about insects' basic needs to survive (e.g., food, water), their common habitats (e.g., beehives, ant colonies), and how insects grow and develop (e.g., metamorphosis). By strategically integrating these core themes throughout all four of the topics, children were provided with many opportunities to review common vocabulary words, as well as opportunities to compare and contrast how these core themes were reflected in each of the content domains. In this respect, the goal was to help children build a knowledge network across life science topics (Gonzalez et al., 2011), supporting more in-depth understandings of vocabulary and concept knowledge.

A typical 8-day sequence (i.e., 2 weeks in a state pre-K classroom) begins each day with a "tuning-in": a rhyme, song, or word-play video clip that is shown from a DVD to bring children together. For the insect topic, for example, children view "Goodbye fly," a rhyming song that introduces them to the topic. After the video, the teacher would say, "Today our video focused on insects. A fly is a type of insect."

The tuning-in is followed by a "content" video that introduces children to the definition of the category. The first video is designed to act as a prototype of the category, a particularly salient exemplar of the topic (e.g., katydid). After the video, the teacher provides an explicit definition of the category—"Insects are very small creatures. There are lots of different kinds of insects, and all insects have six legs"—followed by a briskly paced call-and-response activity. For example, the teacher might ask, "Do katydids live with people?" (No, the children chorally respond). "Where do they live?" (outside). "And how many legs does a katydid have?" (six).

The words are then reinforced using an information big book (i.e., in this case, on insects) specially designed to review the words just learned (e.g., Tier 2 and Tier 3 words such as *antennae, familiar, wings, outside*), and to provide redundant information in a different medium. Here, the teacher reads about the topic in a different, meaningful context using the genre features of information text throughout the readings (e.g., pointing to visual features in the book to identify the label). For example, the teacher holds up the book and tells children to look closely at the picture of the katydid. "The arrows show you which part of the katydid to look at." She then points to each segment of the katydid's body, and counts, *one, two, three.* The next time she encourages the children to count with her as she points to each segment. "Once more," she says, "only let's use the names of each segment: *head, thorax, and abdomen*" as they repeat along with her.

On subsequent days, teachers provide increasing supports to develop knowledge of these words, using additional videos (i.e., a total of four per topic) that focus on new words both in and outside the taxonomic category to help build children's key conceptual knowledge. New words and properties are introduced, and previous ones are reviewed. For example, the teacher says, "The video was about katydids. Like most insects, katydids live outside. Katydids are green and they can use their color as camouflage. A green katydid looks like a green leaf. This keeps it safe from its enemies who might hurt it." Then, using the picture cards, she says, "Let's play a game. We've learned some ways that all insects are alike and some ways they are different from each other. I'm going to point to two insects, and you tell me one way that those two insects are alike or different. What is one way that a moth and a katydid are alike [e.g., they both use camouflage]. What is one way that an ant and a bee are different? [e.g., bees have wings and ants don't]."

In addition, videos and teacher questions while reading the information books are designed to deepen children's understanding by providing additional information about the core themes as they relate to the topic (e.g., insects live in a habitat that has the food, shelter, and weather they need). Following the video, the teacher uses the information book and picture cards to engage children in sorting tasks, including words that are not clearly in or out of the category (e.g., Is a bat an insect?), challenging children by giving them problems to solve, such as "time for a challenge." These challenge items are designed to encourage children to apply the concept knowledge they have acquired to think critically about what may or may not constitute category membership (Wellman & Gelman, 1998). For example, the teacher says, "I'm going to try and trick you with a challenge. I will challenge you to tell me whether the creature is or is not an insect." She holds up a picture of a spider. The children respond, "No, it is not an insect." She replies, "Tell us why." In response a child replies, "Insects have six legs, and a spider has eight legs, so a spider is not an insect." Lastly, the children review their learning through journal writing activities that involve developmental (i.e., phonic) writing. Children are asked to draw a picture of what they have learned, and the teacher helps to caption it.

The instructional sequence is designed to help teachers scaffold children's learning. In the beginning, for example, the teacher's lesson plan focuses on explicit instruction, helping children to "get set" (i.e., providing background information) and "give meaning" (i.e., providing concept knowledge) to deepen their understanding of the topic. As the instructional sequence progresses, the teacher begins to "build bridges" to what children have already learned and what they will learn (i.e., establishing intertextual linkages across media). Here the teacher begins to release more control to the children. Finally, the teacher is encouraged to "step back," giving children more opportunities for open-ended discussion. At the end of the instructional sequence, children are given a "take-home" book, a printable version of the information book used in the lesson. All topics follow a similar instructional design format.

Therefore, the unique potential of categories to bootstrap word learning by linking word labels to existing knowledge through inductive processes (Gelman & O'Reilly, 1988) is the primary mechanism for word learning and concept knowledge development in the curriculum. That is, once a category has been established, children may use information about the category to generalize to new instances and to make inferences (Rehder & Hastie, 2004). For example, when told that the unfamiliar word *katydid* refers to a kind of insect, a child can infer that katydids possess antennae and thoraxes based on his/her existing insect knowledge. In fact, children as young as 2 years of age have been shown to use category membership to make novel extensions and inferences about living things (Gelman, Coley, Rosengren, Hartman, & Pappas, 1998). Moreover, in our previous research (Neuman & Dwyer, 2011), invoking category membership during the word-learning process appeared to provide children with a rich conceptual and semantic background that scaffolded vocabulary acquisition.

Measures and Data Collection

We used a standardized measure of receptive vocabulary and a battery of experimenter-developed measures to assess children's vocabulary, conceptual knowledge development, core theme knowledge, and understanding of the genre characteristics of information text. All assessors had over 5 years of testing experience among preschool children. They were trained on this battery and tested until they reached 100% interassessor reliability on all study measures prior to formal testing with children. Researchers were blind to the treatment status of the classrooms when assessing children. All measures were administered individually. Measures were administered 2 weeks prior to the intervention and 2 weeks after completion of the intervention.

Vocabulary knowledge. We used two receptive measures to examine vocabulary knowledge: a standardized measure and a curriculum-specific measure.

Overall receptive vocabulary. We used the PPVT-IV (Dunn & Dunn, 2007), a standardized assessment that provides both raw and standard scores, to measure overall receptive vocabulary. On the PPVT, the assessor provides a verbal prompt and the child is requested to point to one of four pictures on a panel that represents the object or the action. Internal consistency ranges from .86 to .98 for both Forms A and B. Standard scores were used in all analyses.

Science-related vocabulary. We also assessed the number of science-related words children learned throughout each topic of instruction using a 40-item receptive task (i.e., 10 words × 4 topics) of the corpora of target words taught throughout each topic. Children were shown three pictures and asked to point to the target word. Of the three pictures, one was the target (e.g., antennae), one was a thematically related out-of-category distractor (e.g., spider), and one was a related in-category distractor (e.g., wing). The ordering of picture type was counterbalanced across items; the order of presentation of items was randomized and then presented in a set order across children. The total number correct was recorded for each student (maximum score = 40). Internal consistency was .66.

Concept knowledge. The curriculum is designed to help children develop conceptual linkages among words. For example, teachers are encouraged to emphasize how words are related (e.g., all insects have a *head, thorax*, and *abdomen*). We used two formats to assess conceptual knowledge.

Yes-no. Four categorical properties from each topic/concept were selected for this subtest. As shown in Appendix Figure A1, for example, a categorical property of "insects" is that they have antennae to smell things. Assessment questions were devised to include the target word in a sentence that was related to the concept (e.g., Does a butterfly have antennae?), or not related to the concept (e.g., Does a grasshopper live in a hive?). Each categorical property was tested using both in-category and out-of-category target words to measure children's understanding of when concept properties could or could not be applied to the target vocabulary words. Children heard an equal number of "yes" and "no" questions across the assessment; the order of these questions was randomized and then presented in a set order across children.

Categorical properties of concepts. This subtest included concept and categorical property type questions. For the concept-level questions, children were shown three pictures: a target picture (e.g., bee), a picture thematically related to the target (e.g., hive), and an out-of-category, but plausible, distractor (e.g., snail). Children were then asked to identify which object belonged to a particular category (e.g., Point to the one that is an insect). For the categorical property questions, children were asked to identify the object that possessed a particular category-like attribute (e.g., Point to the one that has six legs).

Together, the conceptual knowledge measure included 64 items, equally distributed across the two subtests. Internal consistency based on Cronbach's alpha was .74.

Core themes. We devised two tasks to measure children's knowledge of the core themes addressed in the intervention. The first task addressed children's understanding of the life cycles of living organisms. In this task, children were shown a picture of an entity at a single point in its life cycle. They were then shown two pictures of the entity at two other points in the life cycle. Children are asked to identify which of the two pictures presents the next point (or the previous point) in the life cycle. For example, children were shown a picture of a chrysalis, followed by pictures of a butterfly and caterpillar. The assessor asked, "When this chrysalis hatches, what will come out?" If children have an understanding of the different life cycles of living organisms, he or she should be able to identify the correct picture (i.e., butterfly).

The second task addressed another key scientific core theme that was integrated across topics: how living things protect themselves. In this task, we slightly adapted the format of the life-cycles task. Here, children were shown two pictures of an entity. One picture included a feature or behavior that could be used for protection, while the other did not show that feature or behavior. Children were then asked to identify which of the two pictures showed the entity "better protected from [variable]." For example, children were shown a picture of a brown moth on tree bark (i.e., protected) and the same moth on grass (i.e., not protected). The assessor asked, "Which one is better protected from predators?" If children have an understanding of different types of protection (i.e., camouflage), then they should select the moth on tree bark. Types of protection included in this assessment included camouflage; traveling in a group or herd; shelter, wearing protective clothing; and possessing protective appendages (e.g., thorns). Together, the content-knowledge tasks included 24 items, with an internal consistency of .53.

Knowledge of the information genre. We adapted the Concepts of Comprehension Assessment (COCA; Billman et al., 2008), a measure designed to examine children's ability to comprehend information books. Originally designed for kindergarten through second grade, we selected a subset of items specifically targeted to address the genre features of information text and adapted them for use with our prekindergarten sample. In this task, children were read a specially designed information book about salmon (Hilden, Billman, & Winchell, 2011). On each page of the book, there is a question about what is happening and what may be learned from the book. For example, children may be read a sentence (e.g., "Salmon lay their eggs at the bottom of streams"), and then be asked to point to the picture that best matches what was just read (e.g., "Point to the picture that goes with the words I just read") (e.g., illustration with caption). On another page, children may be asked to recall what was learned on that page (e.g., "This page teaches you a new word. What is that word?") (e.g., bold print/word in glossary). There were a total of 16 questions; each question was worth two points to account for partial answers, for a total potential score of 32. Internal consistency was Cronbach's alpha = .63.

Therefore, although the internal consistency of several of measures was below desirable levels, these assessments were considered within the acceptable range for researcher-developed measures (Shadish, Cook, & Campbell, 2002). Further, Gersten and his colleagues (Gersten et al., 2005) have asserted that lower reliabilities can be considered acceptable for newly created measures and can indicate that a coherent construct is being assessed.

Vocabulary and conceptual knowledge assessments were administered as pre- and posttests individually to children. Knowledge of core themes and the knowledge of information-book genre characteristics, however, were administered as posttests only. Previous pilot testing had indicated the potential of floor effects at pretest for these measures prior to any intervention. Because pretest scores would not likely yield useful information, we decided for the sake of parsimony to rely on posttests only and to examine posttest scores in comparison with the control group. Consequently, the standardized vocabulary measure was used as a covariate in analyzing children's content knowledge and genre outcomes.

Procedure

One week prior to implementation, teachers in the treatment group participated in a full-day professional development session led by the project team. In this session, we introduced the rationale, materials, and procedures of the intervention.

Teachers were also introduced to the instructional design, and received materials that included detailed lesson plans for each topic, DVDs of the video clips, information books, and picture cards. In addition to the professional development session, a member of the project team visited teachers once a week to review progress and resolve implementation issues as necessary.

The intervention began in January and lasted for 12 weeks. Sessions were designed to take between 12–15 minutes daily, and typically replaced a portion of the whole-group time. Comparison teachers in the control group, on the other hand, engaged in "business as usual" activities, selecting their own storybooks and reading aloud daily to children. Book selection in these classrooms included favorite storybooks as well as an occasional information text. Both treatment and control groups continued to provide hands-on materials and multisensory science experiences as part of the High/Scope curriculum framework (e.g., focusing on scientific processes such as observing, classifying, experimenting, predicting, drawing conclusions, and communicating ideas to others) to support preschoolers' scientific competencies and to help them develop the habits of mind and skills associated with scientific thinking. Although the High/Scope curriculum provides key developmental milestones and suggested activities, as a framework it does not include systematic instruction in language, literacy, or in the content areas. Consequently, throughout the study we saw no overlap between the High/Scope curriculum and WOW.

Fidelity of Treatment

We developed a measure of treatment fidelity to examine the extent to which the critical intervention components were enacted, as well as the quality of the enactment. Content coverage included whether each part of the lesson was delivered (i.e., video clip, information book, picture cards, time for a challenge, discussion). Quality features included whether the lesson was well paced, engaging, facilitative of discussion, and whether teachers were responsive to children's comments and questions.

Two sessions per topic were rated for each teacher, staggered in such a way so that each component of the 8-day lesson was observed at least once. Visits were unannounced; teachers were not told beforehand of the anticipated visit. During the visit, a trained research assistant indicated the absence or presence of each feature. These scores were tallied for content and quality, creating a total fidelity score. The research assistant also wrote field notes to provide additional detail on instructional behaviors as they occurred. A second research assistant, blind to the study's hypotheses, viewed 10 videotaped lessons and coded for fidelity. Interrater agreement was 100%. Fidelity indicated an average of 88% for content coverage and 89% for quality features, indicating high fidelity to treatment throughout the study.

Results

Due to the nested structure in our data (i.e., 268 children; 17 classrooms), we first chose multilevel modeling to analyze the data, taking into account the non-independency of our data. Multilevel modeling is preferred over traditional fixedeffects models for nested data, in which individuals within a group are not independent. Given that children were nested within classrooms, we employed two-level models to examine differences for each child outcome.

However, preliminary analyses revealed no significant intraclass correlations among classrooms for the dependent variables (ICC < 0.001 for vocabulary and core themes assessments; ICC $= 0.007$ for concepts) with the exception of the Concepts of Comprehension Assessment (COCA) (ICC $= .11$). This analysis indicated that our participants varied more individually than they did by classroom, and therefore met the assumption of independence (Kenny & LaVoie, 1985). Consequently, subsequent analyses of the differences between groups were examined using analysis of covariance, with the exception of the COCA, which was examined with a hierarchical linear model (HLM). In the following section, we address the effects of our shared book-reading intervention on children's outcomes. Table 3 reports the intercorrelations of our measures.

Based on our quasi-experimental design, we conducted analyses of covariance (ANCOVA) to control for initial differences between groups. We used treatment as our independent variable and pretest scores as covariates to analyze differences among children who received the vocabulary intervention and those who continued with business as usual. Because the ethnicity of our treatment and control groups differed significantly, we also included students' minority status as a covariate in all analyses. Next, we investigated whether there were differential patterns of learning based on children's initial receptive language skills that result from the intervention.

We then examined the effects of the intervention on children's knowledge of core themes, using PPVT and minority status as covariates and treatment as our independent variable. Previous studies (e.g., Coyne, Simmons, Kame'enui, & Stoolmiller, 2004) have reported larger gains for children who begin with higher language scores, increasing the vocabulary gap rather than closing it. Finally, given that regular exposure to information text was an integral part of the intervention, we examine differences between groups on children's understandings of the information genre.

The Effects of Curriculum on Vocabulary and Conceptual Knowledge

Our first question was to examine the impact of a science-focused shared book-reading intervention on children's vocabulary and conceptual knowledge. Pretest and posttest measures are listed in Table 4. Independent *t*-tests revealed no signif-

Table 3. Intercorrelations among Assessments at Posttest

	1	2	3	4	5
1. PPVT	–				
2. Science vocabulary	.56**	–			
3. Concept knowledge	.55**	.56**	–		
4. Content knowledge	.50**	.52**	.52**	–	
5. Genre features	.41**	.49**	.51**	.29**	–

** $p < .01$.

Table 4. Percentage Means (and Standard Deviations) of Children's Outcomes by Condition

	Treatment		Control	
Measure	Pretest	Posttest	Pretest	Posttest
PPVT	100.66 (13.04)	100.92 (12.90)	99.56 (12.99)	98.69 (13.13)
Science vocabulary	.67 (.11)	.80 (.11)***	.67 (.10)	.69 (.11)
Concepts	.68 (.09)	.74 (.10)**	.68 (.09)	.71 (.09)
Content knowledge		.68 (.13)**		.63 (.13)
COCA		.40 (.19)*		.35 (.15)

* $p < .05$.
** $p < .01$.
*** $p < .001$.

icant differences between groups prior to treatment. Following treatment, however, there were significant differences for curriculum-based science vocabulary and concept knowledge measures.

To examine differences between groups, we conducted an ANCOVA with pretest scores and minority status serving as covariates and treatment condition as independent variable. Our analysis revealed significant differences between groups at posttest. Children in the treatment group gained significantly more on vocabulary, $F(1, 262) = 69.23$, $p < .001$, $d = 1.10$. Entered as covariates, children's pretest score was significant ($F(1, 262) = 88.49$, $p < .001$, partial $\eta^2 = .25$), but minority status was not ($F(1, 262) = 5.58$, $p = .223$). Children in the treatment group also gained significantly on conceptual knowledge, $F(1, 262) = 8.86$, $p = .003$, $d = .33$. There was also a significant effect in this analysis of both covariates: pretest scores ($F(1, 262) = 82.95$, $p < .001$, partial $\eta^2 = .24$) and minority status ($F(1, 262) = 8.63$, $p = .004$, $d = .53$). However, there were no significant effect of condition for overall receptive vocabulary (i.e., PPVT), $F(1, 262) = 1.19$, $p = .276$. Children's pretest scores on the PPVT ($F(1, 262) = 298.67$, $p < .001$ partial $\eta^2 = .53$) and minority status ($F(1, 262) = 6.60$, $p = .011$, $d = .86$) were both significant covariates. These results indicated that children in the treatment group gained significantly more science-related vocabulary and concepts than the control group who engaged in business-as-usual shared book-reading activities. However, for both groups, overall receptive vocabulary remained stable throughout the intervention period.

Next, we examined whether there were differential effects for children based on their initial receptive language scores. For this analysis, we conducted linear regressions using children's pretest PPVT scores to predict their posttest scores on the curriculum-related vocabulary and conceptual knowledge measures, as well as their gains from pre- to posttest. These results are reported in Table 5. Our analysis

Table 5. Regression Analyses of Children's PPVT Scores Predicting Overall Treatment Outcomes as Well as Gains in Treatment Scores

Outcomes	β[a]	t-value	p-value
Science vocabulary total score	.46	8.06	< .001
Concepts total score	.40	6.93	< .001
Gains in science vocabulary	−.062	.96	.338
Gains in concepts	.01	.14	.888

[a] Standardized regression coefficient.

indicated that PPVT was strongly related to children's overall scores on vocabulary and conceptual knowledge. However, it did not predict students' gain scores on either measure. Although children who had lower initial receptive vocabulary knowledge scored lower than others who had greater knowledge at the start, the rate of learning throughout the intervention period was approximately the same. Results of this analysis, therefore, indicated that the intervention did not exacerbate the gap based on initial receptive language scores. Regardless of incoming scores, children appeared to learn an equivalent number of words and concepts as those entering the program with higher receptive language scores.

The Effects on Knowledge of Core Themes

Our second question asked specifically whether the intervention improved children's knowledge of core themes that were addressed throughout the intervention. Given that the task devised was administered only as a posttest, we used the PPVT as covariate to control for differences in receptive language, along with students' minority status. Our analysis revealed statistically significant differences between groups in children's understanding of core themes. As shown in Table 4, children in the treatment group appeared to gain greater core theme knowledge than those in the control group, $F(1, 262) = 7.696$, $p = .006$, $d = .38$. Students' minority status was not a significant covariate ($F(1, 262) = .001$, $p = .991$), but PPVT was a significant covariate ($F(1, 262) = 67.95$, $p < .001$, partial $\eta^2 = .21$). These results indicated that the intervention seemed to deepen children's understanding of core themes, building a more coherent knowledge network in the life sciences.

The Effects on Genre Features of Information Text

The third and final research question asked whether the intervention improved children's understanding of the features and the purposes of information text. For example, children were asked to identify what types of things a book about "salmon" might tell a young reader, as well as other features, such as labeling and identifying how illustrations might work to provide information to the reader. Because of the higher ICC for this measure (.11), a two-level hierarchical linear model (HLM) was used with classroom entered as a random intercept. Using the PPVT and minority status as covariates, the analysis indicated statistically significant differences between the treatment and control groups, $F(1, 259) = 5.58$, $p = .019$, $d = .29$ (see Table 6). PPVT was also significant ($F(1, 259) = 43.36$, $p < .001$), but minority status was not ($F(1, 259) = 1.26$, $p = .263$). These results indicated that through their

Table 6. Model Specifications of Hierarchical Linear Analysis for Models with Independent Variables Entered Alone

	Condition		PPVT		Minority Status	
Outcome	Estimate	*SE*	Estimate	*SE*	Estimate	*SE*
Concepts of Comprehension Assessment	.05	.02	.005	.001	.025	.02

many experiences with information text, children in the treatment group appeared to better understand the purposes and functions of information books than those children in the control group.

Discussion

In this study, we examined the efficacy of a shared book-reading approach to integrating literacy and science instruction. Our purpose was to determine whether an intervention targeted to teaching vocabulary in categories could improve low-income children's word knowledge, conceptual development, and core theme knowledge in the life sciences. Our rationale was that the earlier such word meanings are learned, the more readily children will develop concepts that could subsequently promote comprehension and content knowledge.

The results of our study show promising evidence to support these claims. Significant effects were reported for children's growth in vocabulary and conceptual knowledge, compared to their counterparts in the business-as-usual classrooms. Furthermore, children in the treatment group were better able to apply their knowledge to an understanding of the core themes related to the survival and life cycles of organisms. These results contribute to the growing body of evidence suggesting that integrated approaches not only benefit children's oral language development (Gonzalez et al., 2011) but also support children's science learning outcomes (Cervetti et al., 2012; French, 2004; Neuman & Kaefer, 2013).

Underlying our shared book-reading intervention was a set of specific theoretical principles regarding the relationship between vocabulary development and scientific learning. These principles included the understanding that vocabulary knowledge taught in categories helps to structure children's developing concepts, and that concepts are closely related to content learning. It also assumed that comprehension of content is highly situated to the context of the text and the background knowledge that listeners or readers bring to that text.

This set of principles also assumes that content knowledge and comprehension, while related, are not synonymous. For example, in a study examining the effects of an integrated approach to science and literacy in elementary school classrooms, Cervetti and her colleagues (Cervetti et al., 2012) found that students made significant gains on measures of science understanding, defined in the study as declarative knowledge. However, the intervention did not lead to gains in children's overall reading comprehension, or the ability to recall main ideas in a researcher-designed set of expository passages. Consequently, their findings suggest that content knowledge is highly dependent on the words and conceptual understandings that students bring to it. At the same time, it also raises the question of whether or not comprehension is a generic skill, as once assumed. If the purpose of comprehension is to develop knowledge through text (Neuman & Roskos, 2012), it suggests that children's understanding of text is not just related but actually dependent on background knowledge.

Supporting this thesis, a 2-year study by McKeown, Beck, and Blake (2009) examined the efficacy of two approaches to teaching reading comprehension to fifth graders in a low-performing urban school district. One approach focused students' attention on the context of the text through open-ended, meaning-based questions about the text; another used strategies instruction that focused on teaching specific procedures to guide students' understanding through text. The results were consistent from both years: Students who received content instruction outperformed those who received strategy instruction on comprehension of lesson texts, lesson discourse (i.e., amount of talk about text), and three transfer tasks.

This distinction is important because it implies that comprehension, as a construct, may be less transferable than previously considered. Rather than an overall skill, comprehension might be text specific, dependent on the extent to which students bring background knowledge to it. If this is the case, it would suggest a more strategic analysis of the vocabulary and concepts needed to comprehend text, and the relationships among the texts themselves. Our integrated program (Neuman et al., 2007), for example, supported children making comparisons and contrasts across multiple texts using a set of common vocabulary and concepts. More than likely, these experiences helped to build a deeper and richer understanding of words in different contexts that led to enhanced comprehension and content knowledge. Instructionally, this might imply that teachers need to place greater attention on the vocabulary and conceptual load of texts rather than on generic comprehension strategy instruction. Additional research that includes a greater attention to transfer measures and a longer timeframe for analysis is clearly needed.

In this study, we also found that children in the treatment group acquired greater knowledge of the information-text genre than those in the control group. Treatment children were better able to identify the purposes for reading an information text, to identify the labels in the text, and to describe how pictures supported the content of the text. These features of information text, however, were often not explicitly taught in the program; rather, it was only through regular exposure to these books and conversations about the content that children learned about these features. These results further confirm Pappas's (1991) contention that children learn about the features and linguistic supports of information text through frequent exposure. Previous studies (e.g., Purcell-Gates, 1988), for example, have found that children who have regularly been read to prior to formal literacy instruction appear to abstract identifiable lexical and syntactic expectations of text. Therefore, the frequent use of information books *before* formal schooling may promote children's understanding of the purposes and different structures of information text.

Nevertheless, studies (e.g., Duke, 2000) suggest that information-book reading is still rare in classrooms, as well as in home settings. Gathering data from over 1,000 primary-grade teachers on titles read the previous day in their classrooms, Yopp and Yopp (2006) reported that only 5% of all titles were informational texts. Similarly, when they examined over 1,800 titles of books read at home, only 7% of books were informational. These findings converged with those of Duke (2000), who found limited access to the informational genre in classrooms, with teachers reading only 1.9 minutes per day in low-SES classrooms. Despite its many benefits, there continues to be a paucity of informational book reading for preschoolers.

This is particularly concerning given that information books are likely to be a primary source of technical vocabulary that enables young children to grasp complex understandings that are central to subject areas. Therefore, even more important than the number of books available, it becomes critical to consider how these information books may be used to support content instruction. In our study, for example, we found that strategically grouping information books in ways that could support greater frequency of exposure to words and concepts enhanced broader knowledge.

Nonetheless, we recognize a number of limitations to our analytic efforts in this study. The most significant is the confound of district in the sample selection. Schools were not randomly assigned to treatment conditions; in fact, treatment condition was confounded with district and school site. Although baseline scores indicated equivalence between the treatment and control groups, clearly we should have randomly sampled within district. Our inability to do so was based on the relatively small numbers of state-based programs in urban fringe school districts, and the potential of carryover if both conditions were located contiguously. Only second to this limitation is the intervention's brief duration of 12 weeks, as well as its focus on only one aspect of science learning, living things. Children were engaged in learning about a topic that is typically of high interest. Therefore, we cannot assume that these relationships would generalize to other science topics and the requisite technical vocabulary and concepts in those areas. In addition, some of our assessments had marginal reliability due to the nature of the assessment. In our future research, we intend to refine and further develop our content-specific measures. Furthermore, due to the potential of a floor effect, content-related measures were assessed only at posttest. Although initial pretest scores between groups showed no evidence of differences between treatment and control groups in receptive language and other measures, ideally it would have been more optimal to measure pre- and posttest gains. Lastly, although presumably both treatment and control groups were involved in daily science and literacy activities through their core curriculum, it was clear that our measures were more closely aligned with the intervention's targeted focus; we cannot assume that the intervention improved early literacy skills or science more globally.

Even with these limitations, this study provides evidence that a content-focused shared book-reading program can enhance vocabulary, concepts, and content knowledge. The implications of these findings are especially significant in the age of Common Core standards and the expectation that children should develop knowledge through text. Our findings provide compelling evidence that word and world knowledge are inextricably connected, and that teachers may play an important role in developing these critical skills.

Appendix

Insects Vocabulary

At a Glance:

Core Content Themes:

- INSECTS have life cycles
- INSECTS live in certain habitats based on their needs.
- INSECTS have ways of protecting themselves.

In this lesson, children will learn:

- INSECTS are small creatures that live all around us.
- INSECTS always have six legs.
- INSECTS most often live outside.
- INSECTS' bodies have three different parts, or segments. These three segments are called the *head, thorax*, and *abdomen.*
- INSECTS also have antennae that they use to smell and feel things.
- We sometimes call INSECTS *bugs*.

Vocabulary:

- Types of INSECTS: *ant, moth, bee, katydid, ladybug, butterfly, grasshopper*
- Words that help us talk about INSECTS: *segments, antennae, wings, outside, camouflage, protect, enemies, survive, head, thorax, abdomen, cooperate, habitat*
- Things that are not INSECTS*: lizard, snail, worm, bat*
- Challenge words*: centipede, spider*

Resources:


Lesson plan


Video clips


Shared reading book


Sorting cards


Puppet

Figure A1. The world of words: at a glance. A color version of this figure is available online.

Note

Susan B. Neuman is professor of early childhood literacy at the Steinhardt School, New York University. Tanya Kaefer is assistant professor of education at Lakehead University, Canada. Ashley M. Pinkham is assistant professor of psychology in the Department of Psychology, Sociology, and Social Work at West Texas A&M University. Address all correspondence to Dr. Susan B. Neuman, e-mail: sbneuman@nyu.edu.

References

Achieve. (2013). *Next generation science standards*. Washington, DC: Achieve.

Beck, I., & McKeown, M. (2007). Increasing young low-income children's oral vocabulary repertoires through rich and focused instruction. *Elementary School Journal*, **107**(3), 251–271. doi:10.1086/511706

Beck, I., McKeown, M., & Kucan, L. (2002). *Bringing words to life*. New York: Guilford.

Billman, A. K., Duke, N. K., Hilden, K. R., Zhang, S., Roberts, K., Halladay, J. L., … & Schaal, A. M. (2008). *Concepts of Comprehension Assessment (COCA)*. Retrieved from http://www.msularc.org/html/project_COCA_main.html

Cervetti, G., & Barber, J. (2008). Text in hands-on science. In E. H. Hiebert & M. Sailors (Eds.), *Finding the right texts: What works for beginning and struggling readers* (pp. 89–108). New York: Guilford.

Cervetti, G. N., Barber, J., Dorph, R., Pearson, P. D., & Goldschmidt, P. G. (2012). The impact of an integrated approach to science and literacy in elementary school classrooms. *Journal of Research on Science Teaching*, **49**(5), 631–658. doi:10.1002/tea.21015

Clements, D. H. (2007). Curriculum research: Toward a framework for "research-based curricula." *Journal for Research in Mathematics Education*, **38**(1), 35–70. Retrieved from http://www.nctm.org/publications/jrme.aspx

Common Core State Standards Initiative. (2010). *Common Core State Standards for English Language Arts*. Washington, DC: Council of Chief State School Officers and the National Governor's Association.

Coyne, M. D., Simmons, D. C., Kame'enui, E. J., & Stoolmiller, M. (2004). Teaching vocabulary during shared storybook reading: An examination of differential effects. *Exceptionality*, **12**(3), 145–162. doi:10.1207/s15327035ex1203_3

Cunningham, A., & Stanovich, K. E. (1991). Tracking the unique effects of print exposure in children: Associations with vocabulary, general knowledge, and spelling. *Journal of Educational Psychology*, **83**, 264–274. doi:10.1037/0022-0663.83.2.264

Cunningham, A. E., & Stanovich, K. E. (1997). Early reading acquisition and its relation to reading exposure and ability 10 years later. *Developmental Psychology*, **33**(6), 934–945. doi:10.1037/0012-1649.33.6.934

Dale, P. S., & Fenson, L. (1996). Lexical development norms for young children. *Behavior Research Methods, Instruments, & Computers*, **28**(1), 125–127. doi:10.3758/BF03203646

Duke, N. K. (2000). 3.6 minutes per day: The scarcity of informational texts in first grade. *Reading Research Quarterly*, **35**(2), 202–224. doi:0.1598/RRQ.35.2.1

Duke, N. K., & Billman, A. K. (2009). Information text difficulty for beginning readers. In E. H. Hierbert & M. Sailors (Eds.), *Finding the right texts: What works for beginning and struggling readers*(pp. 109–128). New York: Guilford.

Dunn, L. M., & Dunn, D. M. (2007). *Peabody Picture Vocabulary Test* (4th ed.). Bloomington, MN: Pearson Education.

Elleman, A. M., Lindo, E. J., Morphy, P., & Compton, D. L. (2009). The impact of vocabulary instruction on passage-level comprehension of school-age children: A meta-analysis. *Journal of Educational Effectiveness*, **2**(1), 1–44. doi:10.1080/19345740802539200

French, L. (2004). Science as the center of a coherent, integrated early childhood curriculum. *Early Childhood Research Quarterly*, **19**(1), 138–149. doi:10.1016/j.ecresq.2004.01.004

Gelman, S. A. (1996). Concepts and theories. In R. Gelman & T. K. Au (Eds.), *Perceptual and cognitive development* (pp. 117–150). San Diego: Academic Press.

Gelman, S. A. (2009). Learning from others: Children's construction of concepts. *Annual Review of Psychology*, **60**, 115–140. doi:10.1146/annurev.psych.59.103006.093659

Gelman, S. A., Coley, J. D., Rosengren, K. S., Hartman, E., & Pappas, A. (1998). Beyond labeling: The role of maternal input in the acquisition of richly structured categories. *Monographs of the Society for Research in Child Development*, **63**(1), i–148. doi:10.2307/1166211

Gelman, S., & Kalish, C. (2005). Conceptual development. In W. Damon & R. Lerner (Eds.), *Handbook of child development* (pp. 298–321). New York: Wiley.

Gelman, S. A., & O'Reilly, A. W. (1988). Children's inductive inferences within superordinate categories: The role of language and category structure. *Child Development*, **59**(4), 876–887. doi:10.2307/1130255

Gersten, R., Fuchs, L. S., Compton, D., Coyne, M., Greenwood, C., & Innocenti, M. S. (2005). Quality indicators for group experimental and quasi-experimental indicators in special education. *Exceptional Children*, **71**(2), 149–164. Retrieved from http://journals.cec.sped.org/ec/

Gonzalez, J. E., Pollard-Durodola, S., Simmons, D. C., Taylor, A. B., Davis, M. J., Kim, M., & Simmons, L. (2011). Developing low-income preschoolers' social studies and science vocabulary knowledge through content-focused shared book reading. *Journal of Research on Educational Effectiveness*, **4**(1), 25–52. doi:10.1080/19345747.2010.487927

Hilden, K., Billman, A. K., & Winchell, M. (2011). *Salmon*. Lansing, MI: Authors.

Hirsch, E. D. (2003). Reading comprehension requires knowledge of words and the world. *American Educator*, **27**, 10, 12, 16–22, 28–29, 48.

Hohmann, M., & Weikart, D. P. (1995). *Educating young children: Active learning practices for preschool and child care programs*. Ypsilanti, MI: High/Scope Press.

Kaefer, T., Neuman, S. B., & Pinkham, A. (2014). Pre-existing background knowledge influences socioeconomic differences in preschoolers' word learning and comprehension. *Reading Psychology*, **36**, 1–29. doi:10.1080/02702711.2013.843064

Kenny, D. A., & LaVoie, L. (1985). Interpersonal relations and group processes: Separating individual and group effects. *Journal of Personality and Social Psychology*, **48**(2), 339–348. doi:10.1037/0022-3514.48.2.339

Leung, C. (2008). Preschoolers' acquisition of scientific vocabulary through repeated read-aloud events, retellings, and hands-on science activities. *Reading Psychology*, **29**(2), 165–193. doi:10.1080/02702710801964090

MacWhinney, B. (2000). *The CHILDES project: Tools for analyzing talk* (3rd ed.). Mahwah, NJ: Erlbaum.

Margolis, J. (1994). Taxonomic puzzles. In J. Z. Sadler, O. Wiggins, & M. Schwartz (Eds.), *Philosophical perspectives on psychiatric diagnostic classification* (pp. 104–128). Baltimore: Johns Hopkins University Press.

McKeown, M. G., Beck, I. L., & Blake, R. G. K. (2009). Rethinking reading comprehension instruction: A comparison of instruction for strategies and content approaches. *Reading Research Quarterly*, **44**(3), 218–253. doi:10.1598/RRQ.44.3.1

Medin, D. L., Lynch, E. B., & Solomon, K. O. (2000). Are there kinds of concepts? *Annual Review of Psychology*, **51**(1), 121–147. doi:10.1146/annurev.psych.51.1.121

Mol, S., & Bus, A. (2011). To read or not to read: A meta-analysis of print exposure from infancy to early adulthood. *Psychological Bulletin*, **137**(2), 267–296. doi:10.1037/a0021890

National Center for Education Statistics. (2011). *The Nation's Report Card: Reading 2003*. Washington, DC: National Center for Educational Statistics. Retrieved from http://nces.ed.gov/nationsreportcard/pubs/main2011/2012457.asp

National Research Council. (2007). *Taking science to school: Learning and teaching science in grades K–8*. Washington, DC: National Research Council.

Neuman, S. B. (1996). Children engaging in storybook reading: The influence of access to print resources, opportunity, and parental interaction. *Early Childhood Research Quarterly*, **11**, 495–514.

Neuman, S. B., & Celano, D. (2012). *Giving our children a fighting chance: Affluence, literacy, and the development of information capital*. New York: Teachers College Press.

Neuman, S. B., & Dwyer, J. (2011). Developing vocabulary and conceptual knowledge for low-income preschoolers: A design experiment. *Journal of Literacy Research*, **43**, 103–129.

Neuman, S. B., Dwyer, J., Koh, S., & Wright, T. (2007). *The World of Words: A vocabulary intervention for preschool children*. Ann Arbor: University of Michigan.

Neuman, S. B., & Kaefer, T. (2013). Enhancing the intensity of vocabulary instruction for preschoolers at risk: The effect of group size on word knowledge and conceptual development. *Elementary School Journal*, **113**, 589–608.

Neuman, S. B., Newman, E., & Dwyer, J. (2011). Educational effects of a vocabulary intervention on preschoolers' word knowledge and conceptual development: A cluster randomized trial. *Reading Research Quarterly*, **46**(3), 249–272.

Neuman, S. B., & Roskos, K. (2012). Helping children become more knowledgeable through text. *Reading Teacher*, **66**(3), 207–210.

Neuman, S. B., & Wright, T. S. (2013). *All about words: Increasing vocabulary in the Common Core classroom, preK–grade 2*. New York: Teachers College Press.

NGSS Lead States. (2013). *Next generation lead states: For states, by states*. Washington, DC: National Academies Press.

Pappas, C. C. (1991). Young children's strategies in learning the "book language" of information books. *Discourse Processes*, **14**(2), 203–225. doi:10.1080/01638539109544782

Price, L. H., Bradley, B. A., & Smith, J. M. (2012). A comparison of preschool teachers' talk during storybook and information book read-alouds. *Early Childhood Research Quarterly*, **27**(3), 426–440. doi:10.1016/j.ecresq.2012.02.003

Price, L. H., van Kleeck, A., & Huberty, C. J. (2009). Talk during book sharing between parents and preschool children: A comparison between storybook and expository book conditions. *Reading Research Quarterly*, **44**(2), 171–194. doi:10.1598/RRQ.44.2.4

Purcell-Gates, V. (1988). Lexical and syntactic knowledge of written narrative held by well-read-to kindergartners and second graders. *Research in the Teaching of English*, **22**(2), 128–160. Retrieved from http://www.ncte.org/journals/rte

Rehder, B., & Hastie, R. (2004). Category coherence and category-based property induction. *Cognition*, **91**(2), 113–153. doi:10.1016/S0010-0277(03)00167-7

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston: Houghton-Mifflin.

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly*, **21**(4), 360–406. doi:10.1598/RRQ.21.4.1

U.S. Department of Health and Human Services. (2010). *Head Start child development and early learning framework*. Washington, DC: Administration of Children and Families, Office of Head Start.

Wellman, H. M., & Gelman, S. A. (1998). Knowledge acquisition in foundational domains. In W. Damon, D. Kuhn, R. Siegler, & R. M. Lerner (Eds.), *Handbook of child psychology: Vol. 2. Cognition, perception, and language* (pp. 523–574). New York: Wiley.

Yopp, R. H., & Yopp, H. K. (2006). Informational texts as read-alouds at school and home. *Journal of Literacy Research*, **38**(1), 37–51. doi:10.1207/s15548430jlr3801_2