Knowledge at the Center of English Language Arts Instruction

Gina N. Cervetti, Elfrieda H. Hiebert

Building students' knowledge is an important way to support their future reading, and this article offers five practices for creating a knowledge-building classroom.

When we think about teaching literacy, we most often think about skills and strategies—the *how* of reading rather than the *what* of reading (Palincsar & Duke, 2004). Yet, dozens of studies over the last five decades have demonstrated the importance of the *what*, that is, the ideas within texts and the knowledge of those ideas that readers bring to the text (for a review of this research, see Cervetti & Wright, in press). Simply stated, the more readers know about the topics of texts, the better their comprehension and learning from texts (e.g., Alexander, Kulikowich, & Schulze, 1994; Gasparinatou & Grigoriadou, 2013). This is probably the best researched and least controversial statement we could make about reading. Many factors contribute to successful comprehension— accurate, fluent word reading, vocabulary knowledge, and the use of strategies to prepare to read and fix up meaning when it breaks down—but in studies that have examined these different contributions to comprehension, knowledge is the most important contributor (e.g., Cromley & Azevedo, 2007; Ozuru, Dempsey, & McNamara, 2009).

Why is knowledge so critical to comprehension? Cognitive theories of reading comprehension, such as Kintsch's (1998) construction–integration model, describe a process in which readers continually integrate their background knowledge with the propositions in a text as they build a coherent understanding of the text. That is, readers use their knowledge to fill out meaning and make connections in a text, and these connections help readers form local and global understandings about the text. Readers' knowledge makes the experience of reading more meaningful and helps them form rich associations with the text, make mental images of the text, and remember what they have read.

In a classic example of how knowledge influences reading, Anderson, Spiro, and Anderson (1978) asked college-age readers to read and recall one of two passages: a narrative about dining in a fine restaurant or a narrative about supermarket shopping. The same food and beverages were embedded in passages in a similar order, but the referents were more consistent with the experience of fine dining. Readers recalled more of the food and beverage items when they read the restaurant passage, suggesting that their ability to associate the items with their knowledge of fine dining made the foods more memorable.

Research has demonstrated that many different kinds of knowledge have a positive impact on comprehension, from knowledge of the topic of the text (e.g., Alexander et al., 1994) to knowledge of the broader domain, such as science (Gasparinatou & Grigoriadou, 2013), to cultural knowledge (Kelley, Siwatu, Tost, & Martinez, 2015) and general world knowledge (Best, Floyd, & McNamara, 2008). Knowledge is associated with better comprehension for readers from elementary students to adults. Importantly, recent studies have suggested that English learners experience similar benefits from knowledge as students whose first language is English, showing stronger comprehension when they bring topic and general world knowledge to reading (e.g., Burgoyne, Whiteley, & Hutchinson 2013; Hwang, 2018).

To illustrate the role of knowledge, consider the following two sentences from the perspective of third or fourth graders. After reading each sentence, ask yourself, What knowledge would students need to understand this text?

Gina N. Cervetti is an associate professor in the School of Education at the University of Michigan, Ann Arbor, USA; email cervetti@umich.edu.
Elfrieda H. Hiebert is the president and CEO of TextProject, Santa Cruz, CA, USA; email hiebert@textproject.org.

1. "The [lion] species' tan coat blends in among the vegetation of its home, helping it to stalk prey" (Lincoln Park Zoo, n.d., para. 1).
2. "Siberian tigers are considered endangered by IUCN's Red List, and one cause of their dwindling population is loss of habitat due to deforestation" (Smith, 2014, para. 9).

Even these short sentences call on considerable background knowledge: the subject (lions, tigers), ecosystems (vegetation, prey), and both lower level biological concepts (animal coats, population, habitats), and higher level biological concepts (significance of camouflage for survival, endangerment and extinction of animals, challenges associated with deforestation). This knowledge is necessary for students to form connections with the text and possibly augment existing knowledge. Imagine the experience of reading these passages without this background knowledge.

In spite of the power and significance of knowledge for comprehension, knowledge building has not often been regarded as a primary goal of literacy education (Palincsar & Duke, 2004). As is described in the next section, two obstacles have hampered an emphasis on knowledge acquisition within literacy instruction.

Why Has Knowledge Not Been a Focus of English Language Arts Instruction?
Prioritizing Activation Over Knowledge Acquisition

In one sense, research showing the importance of knowledge has had a huge impact on educational practice in the form of activating students' existing knowledge about themes, events, or concepts in texts prior to reading. The logic behind knowledge activation is that helping students bring relevant prior experiential knowledge to the foreground makes it more likely that they will use that knowledge to understand the text. An example of knowledge activation before students read *Germs Make Me Sick!* by Melvin Berger, an informational text, is to ask about times students have been ill or what they already know about germs. Or, a teacher might introduce

Charlotte's Web by E.B. White, a narrative story, by asking students about their experiences with friends, a core theme in the novel.

Activating knowledge can have benefits for readers who have knowledge relevant to the topic (e.g., Hansen, 1981; Spires & Donley, 1998). However, activating knowledge has limitations. First, knowledge activation activities are not particularly helpful for students who do not have relevant background knowledge (e.g., Alvermann, Smith, & Readence, 1985; Peeck, Van den Bosch, & Kreupeling, 1982). Typical knowledge activation activities can serve to privilege students from mainstream backgrounds and to marginalize students whose background knowledge may be less aligned with topics addressed in school. English learners can be among those whose rich funds of knowledge are overlooked in knowledge activation activities (Rios-Aguilar, Kiyama, Gravitt, & Moll, 2011). Second, as students focus on their existing knowledge about a particular text, they are not being supported in expanding their background knowledge in ways that support comprehension with future texts. Finally, knowledge activation activities can often focus on fairly superficial connections to the ideas of texts to generate interest, rather than calling up substantive knowledge that will enhance understanding of the text.

Whereas knowledge activation has become a common instructional practice in reading instruction, building knowledge for reading has not (Palincsar & Duke, 2004). Knowledge building involves an emphasis on supporting understanding of big ideas and important concepts through extended reading and other experiences. Returning to an earlier example, building students' broad knowledge of germs has utility beyond understanding a particular text.

A False Dichotomy Between Learning to Read and Reading to Learn

Two phrases are often presented as if they represent a sequence in students' reading development: "learning to read" and "reading to learn." The assumption underlying these terms is that students need to recognize words before they can begin learning content

> **PAUSE AND PONDER**
>
> ■ How much time do students spend reading conceptually and thematically rich texts in your classroom?
>
> ■ What other opportunities do students have to build their knowledge of important concepts about the natural and social world?
>
> ■ What resources are available in your school to create a purposeful, knowledge-focused English language arts curriculum?

from texts (National Center to Improve the Tools of Educators, 1996). In the "learning to read" phase, students read simple stories with familiar content. Only after students have cleared the hurdle of the basics do they receive text with rich content: texts about the natural world, machines, faraway cultures, and so forth.

It is true that accurate, fluent word recognition underlies proficient reading. However, the argument that students first learn to read and then use text to learn is fundamentally flawed. Often, young students are given decodables in which the majority of words have regular grapheme–phoneme patterns, but concepts represented by the words can be trivial and, in some cases, nonsensical (e.g., texts about rams wearing tams and pushing prams). Even while students are learning to read words, they can and should have opportunities to build knowledge from texts with worthwhile ideas and words. Delaying attention to knowledge building can be especially disadvantageous for students whose academic experiences occur primarily in schools.

Five Knowledge-Building Practices

We offer five practices that can increase an emphasis on knowledge building in classrooms. Whatever students' reading level, the takeaway message is that reading instruction needs to focus on building knowledge that will support them in understanding the texts at hand while preparing them for future texts.

Practice 1: Ensure That Students Read a Lot

Becoming good at any complex activity, whether it is playing a musical instrument or reading, requires that individuals participate in the activity a lot. As students read, they acquire world and word knowledge, consolidate reading strategies and skills, and gain insights into the nature and structure of different kinds of text. All of this creates momentum and motivation for future reading. Students who do not read much will not achieve the same momentum or motivation. Stanovich (1986) referred to this phenomenon as a Matthew effect: The rich get richer, and the poor get poorer.

In 1977 and again more than 30 years later, Allington (1977, 2009) asked, "If they don't read much, how they ever gonna get good?" Reading volume, as Allington (2014) demonstrated in a review of research, can be increased in classrooms to

good effect. Kuhn et al. (2006) found that increasing the amount of reading by second graders, whether through wide reading or repeated reading, resulted in more growth in word reading, fluency, and reading comprehension, compared with students in classrooms where increased reading was not a focus.

Especially relevant to the theme of this article, reading volume is associated with general world knowledge. In Stanovich and Cunningham's (1993) analysis of the contributions of general reading ability, reading volume, and television exposure to general knowledge among college students, television exposure was shown to not contribute to knowledge, but reading volume contributed substantial variance in tests of academic and everyday practical knowledge. In a replication of Stanovich and Cunningham's study, Sparks, Patton, and Murdoch (2014) confirmed the close connections among reading volume, reading achievement, and knowledge.

Even though the amount of time devoted to English language arts (ELA) instruction has increased steadily over the past decades, students appear to be spending less time reading in school. Brenner, Hiebert, and Tompkins (2009) documented an average of just 18 minutes of "eyes on print" reading per day in third-grade ELA periods. Similarly, in observations of second- through fourth-grade classrooms, Jeong, Gaffney, and Choi (2010) found that the total number of minutes students spent in talking, listening, reading, and writing related to all types of text was relatively small, averaging 44 minutes across a school day in grade 2 and 50 minutes in grades 3 and 4.

There is no definitive answer to the question of how much independent reading students should do (Miller & Moss, 2013), but it is clear that opportunities for independent reading in classrooms are essential for reading development. There are several ways in which teachers can design their ELA periods and school days to increase the quantity and quality of students' reading.

Providing consistent times for independent reading is an important way to build the habit of reading. Students' stamina for reading can be supported by slowly expanding time devoted to independent reading and by establishing routines for documenting the amount of text that students read (Mesmer, 2015). Ensuring that students always have a text close at hand means that time that might otherwise be spent unwisely can be devoted to silent reading. Opportunities to read and to set goals for increased

reading can be extended to out-of-school contexts through take-home books and reading logs, as well as at-home activities that involve families in reading and talking about books.

Teacher read-alouds serve to introduce students to new topics, genres, and authors. Consider, for example, the topic of the critical role of water for all living things on Earth—humans, animals, and plants. Numerous texts can be found on the topic, such as *The Water Princess* by Susan Verde, a true story about a young girl in Burkina Faso who daily makes a long trek with her mother to get water. As part of the discussions that follow this read-aloud, teachers can introduce additional books on the topic that students can read on their own, such as *You Wouldn't Want to Live Without Clean Water!* by Roger Canavan and *One Well: The Story of Water on Earth* by Rochelle Strauss.

Practice 2: Choose Engaging and Conceptually and Thematically Rich Texts

Often, the texts assigned to students for reading instruction or even independent reading are based on evaluations from text complexity systems that predict the right level of texts for students, rather than on the content of the texts (Hiebert, 2017). Choosing texts that have rich ideas and sophisticated themes can help students build world and word knowledge to support future reading. These texts can be of many different genres, including fictional stories, but access to high-quality informational texts is essential for students to become knowledgeable readers. Until quite recently, ELA instruction in elementary school classrooms was dominated by narrative text. In the study by Jeong et al. (2010) described previously, instructional time spent with informational text in grade 2 averaged one minute during four hours of instruction, including reading, writing, language arts, science, social studies, health, and math instruction. At third and fourth grades, the amount was an average of 16 minutes. Other studies have found similarly low levels of informational text across the early school grades (e.g., Pentimonti, Zucker, & Justice, 2011; Yopp & Yopp, 2006). Creating a better balance of narrative and informational reading is vital for knowledge-enhancing classrooms.

Building sets of texts can increase the focus on knowledge. In addition to building knowledge, reading sets of related texts (also called conceptually coherent reading or narrow reading) is associated with growth in vocabulary acquisition (Cervetti, Wright, &

Hwang, 2016; Hansen & Collins, 2015). Standards can provide a good guide for creating concept-based text sets, although another way to start is to select one excellent text and then build a set of texts around it.

In our work with teachers across the elementary grades, we have engaged students in reading sets of texts on topics from birds to oceans. When we build the sets, we are careful to consider how concepts (e.g., the diversity of life in the ocean, the ways that birds work together to protect their chicks) are discussed across books. We have witnessed how students are able to form sophisticated connections as we read and discuss the books (Cervetti, Wright, & Hwang, 2015).

Even when working with individual texts, we work to maintain a focus on big ideas by asking ourselves, What are the important ideas and themes in this text? How can I help students understand and engage deeply with these ideas in and beyond the text? What other kinds of insights about text and language can students glean from this text?

Two critical questions frequently arise in discussions with teachers about knowledge building: What knowledge should we be building? What should students be reading about? There is value in a wide range of knowledge and themes. Standards are an excellent guide (see NGSS Lead States, 2013), and connecting to content area instruction is a powerful (and time-economical) practice. Consider complementary instruction across science or social studies (or math, music, art, or physical education) and ELA. The integration of ELA with science investigations has proven to be particularly productive, with several studies showing positive impacts on students' literacy learning and conceptual knowledge (e.g., Cervetti, Barber, Dorph, Pearson, & Goldschmidt, 2012; Guthrie et al., 2009; Romance & Vitale, 2001).

Practice 3: Teach Students to Use Their Knowledge to Comprehend Text

Even when students have relevant knowledge, they are not necessarily skilled at bringing that knowledge to bear on texts. They often either fail to bring their knowledge to the text (Barnes, Ahmed, Barth, & Francis, 2015; Brandão & Oakhill, 2005) or activate their knowledge—relevant and irrelevant—in an unconstrained way, making it difficult to achieve a clear understanding of the text (Cook & O'Brien, 2014). This pattern was evident in Brandão and Oakhill's study, in which they first asked 7- and 8-year-olds literal and inferential questions

about a text they had read, then asked students to justify their answers ("How do you know this answer?"). Brandão and Oakhill found that students relied mainly on the text in answering questions, even questions that were designed to require integration between prior knowledge and textual information.

Being able to form inferences based on prior knowledge and on ideas encountered previously in texts is an essential skill underlying successful reading comprehension (Barnes et al., 2015; Denton et al., 2015). However, students may need support to develop this skill, such as teaching them to activate knowledge from memory—as they read, not just as a prereading activity—and teaching them to integrate that knowledge with information in a text. There are several additional ways to support students' skill in forming inferences.

First, higher level questions invite students to form connections to ideas, situations, and experiences beyond the particular piece of text being discussed. In doing so, these questions demand the use of prior knowledge. Higher level questions reach beyond the facts or events of a text toward "generalization, application, evaluation, or aesthetic response" (Taylor, Peterson, Pearson, & Rodriguez, 2002, p. 18). Going back to the example sentence about lions' coats, higher level questions or prompts might invite connections to big scientific concepts, such as survival (e.g., "How might being able to blend in help lions survive?"), or might ask students to connect this fact about lions to other animals they have read about (e.g., "Let's think about other animals that blend in with their environments").

Higher level questions are the first step. They need to be followed by dialogue in which students provide evidence, examples, clarification, and elaboration if inferencing and knowledge building are to occur (McElhone, 2012). Opportunities to engage in teacher-led and peer-to-peer discussions involving sophisticated texts and tasks have been shown to lead to knowledge and comprehension development (e.g., Driver, Newton, & Osborne, 2000; Pappas, Varelas, Barry, & Rife, 2002). The effects of social collaboration can result in increased student motivation and achievement, including higher levels of engagement with texts (Antonio & Guthrie, 2008). Various forms of social collaboration, such as student-led discussions and text-based collaborative reasoning (Wilkinson & Son, 2011), can aid students' knowledge building. Digital contexts also offer promise in expanding the options open to teachers and students in creating collaborative contexts where students engage in knowledge-building activities with peers within their immediate educational contexts and extended contexts (So, Seah, & Toh-Heng, 2010).

Second, explicit instruction about how to make different kinds of connections in text can support inference making. In particular, modeling for students how to form connections and bring knowledge to bear can be effective. Turning again to the lion sentence, a teacher might model connections through statements such as these:

- "When I read this sentence about lions, I thought about what I know about how lions look. Here's what I picture in my mind…" (connection to prior knowledge)
- "I am remembering a picture I saw of a lion in the grass…" (connection to a previously encountered visual text)
- "I remember that earlier in the passage, it described how lions hunt for food. I bet the ability to blend in is really helpful for hunting." (connection across different parts of a text)

Third, a range of media, including texts, objects, images, and cartoons, can be used for practice in inferring. A well-known Gary Larson cartoon is set in a pet shop. On one side of the shop is a cat with wooden front legs, peering across the shop to a fish bowl labeled "Piranha, $29.99." A discussion aimed at inference making around this cartoon might begin with a question such as, "What is happening—or has happened—in this cartoon? How do you know?" To understand this cartoon, viewers need to bring prior knowledge about pet shops (very different animals coexisting), cats (like to eat fish), and piranhas (flesh-eating fish), but viewers also need to make the connection that, at some point, the cat tried to eat the fish and was injured in the process.

These are the same kinds of connections—to prior knowledge and across different parts of a text—that make reading meaningful. Forming connections helps us construct richer meaning than just describing what we see or describing the literal events of a text. Like cartoonists, authors do not tell everything, relying on readers and viewers to make connections and fill in meaning. Similarly, educators want to teach students to form many kinds of connections, including making links between different parts of a text, bringing prior knowledge to the text, associating words with their meanings, and summarizing and inferring big ideas, themes, and morals.

Practice 4: Infuse Literacy Into Content Area Instruction

Above all, teachers should focus on teaching content (e.g., science, social studies) in designated times and on integrating content into ELA periods. Morton and Dalton (2007) described how the time spent in social studies instruction was diminishing. This pattern was confirmed in a 2011 report (Scull & Winkler, 2011) that showed a drop of 18 hours in instructional time spent on social studies in elementary schools between 1987 and 2003. Blank (2012) found that instructional time in science had dropped to an average of two hours per week by 2008, the lowest level for more than two decades. In contrast, time spent on ELA instruction averaged 11.7 hours per week. Blank also reported that the amount of time spent on science instruction was associated with National Assessment of Educational Progress science scores at grade 4. Such findings indicate that students are having fewer opportunities to engage in content area learning.

Sacrificing content area instruction denies students opportunities to develop the critical knowledge needed for success later in school and in college, careers, and engaged citizenship. We have worked with teachers and on curriculum development projects that bring a strong focus on literacy in content area instruction (e.g., Cervetti et al., 2012). These literacy experiences are designed to support students' growth in content knowledge in ways that support their involvement and success in content area investigations. In our science units, students read, write, and talk as they investigate, using many of the literacy practices that professional scientists use in their work. For example, students read accounts of other scientists' investigations as they plan their own, and they use field guides and reference books to make sense of their observations. Forming connections to content area disciplines does not mean turning to content area textbooks for ELA instruction. A topic can be explored in depth with numerous different types of texts (including trade texts and magazine articles), demonstrations, and experiments.

Practice 5: Give Students Real Reasons to Read (and Write)

Reading and writing for authentic purposes has been shown to predict growth in reading and writing (Purcell-Gates, Duke, & Martineau, 2007). Duke, Purcell-Gates, Hall, and Tower (2006) defined authentic literacy activities as those that "replicate or reflect reading and writing activities that occur in the lives of people outside of a learning-to-read-and-write context" (p. 346). That means that reading and writing serve purposes other than simply doing school. In addition, giving students reasons to read places a premium on in-depth knowledge, is motivating, and helps students gain insight into why we read and write (Guthrie et al., 2006).

An example of an authentic knowledge-building literacy activity for fourth graders is gathering data on how water is used in their school and reading experts' recommendations for water conservation practices. Students can use findings from gathering data and reading to make recommendations for water conservation practices in their schools and communities. In addition to building knowledge and motivation, purposeful activities such as these provide opportunities for extensive reading of diverse genres of text. In the water example, students might read science articles and fiction and nonfiction trade texts. They might read and create charts about water use. They might engage in interviews with school administrators and local experts, taking notes and summarizing what they learn. They might create a slide presentation to share key points with members of their communities.

Although class projects offer powerful opportunities to develop knowledge and motivation for reading, students should also be given opportunities to pursue their own interests through self-selected reading and research. When students are given choices of sections of a book or different articles on a topic, they have real reasons to communicate to their peers what they have learned—and perhaps to inspire others' interest in the topic.

Hope for the Future

We recognize that building knowledge using current instructional materials requires substantial effort and ingenuity on the part of teachers. We hope that the emphasis on informational text and knowledge building in research and standards will bring better resources in the future. We believe that a commitment to knowledge building is especially essential in light of the diversity of our classrooms. For students who come from marginalized communities and for those who speak first languages other than English, ELA experiences that place a premium on students' existing knowledge and on ensuring that all students develop rich, deep, relevant bodies of knowledge are the means whereby

TAKE ACTION!

1. Extend the time students spend reading by making accessible, content-rich books available to every student, allotting time each day for independent reading, and implementing routines for keeping track of reading.

2. Use read-alouds to engage students with thematically and conceptually sophisticated texts, and teach students to form connections within texts and to prior knowledge.

3. Read your grade-level content standards with an eye to big ideas and concepts that might lend themselves to class-wide projects.

these students will gain the literacies required for the 21st century.

In the meantime, even small steps toward knowledge-building ELA instruction are important in supporting students' long-term engagement with school learning. After all, the goal of ELA instruction is not accurate word reading. The goal is understanding and learning from text—and, ideally, developing a love of reading—and this requires knowledge of the world.

REFERENCES

Alexander, P.A., Kulikowich, J.M., & Schulze, S.K. (1994). How subject-matter knowledge affects recall and interest. *American Educational Research Journal*, *31*(2), 313–337. https://doi.org/10.3102/00028312031002313

Allington, R.L. (1977). If they don't read much, how they ever gonna get good? *Journal of Reading*, *21*(1), 57–61.

Allington, R.L. (2009). If they don't read much…30 years later. In E.H. Hiebert (Ed.), *Reading more, reading better* (pp. 30–54). New York, NY: Guilford.

Allington, R.L. (2014). How reading volume affects both reading fluency and reading achievement. *International Electronic Journal of Elementary Education*, *7*(1), 13–26.

Alvermann, D.E., Smith, L.C., & Readence, J.E. (1985). Prior knowledge activation and the comprehension of compatible and incompatible text. *Reading Research Quarterly*, *20*(4), 420–436. https://doi.org/10.2307/747852

Anderson, R.C., Spiro, R.J., & Anderson, M.C. (1978). Schemata as scaffolding for the representation of information in connected discourse. *American Educational Research Journal*, *15*(3), 433–440. https://doi.org/10.3102/00028312015003433

Antonio, D., & Guthrie, J.T. (2008). Reading is social: Bringing peer interaction to the text. In J.T. Guthrie (Ed.), *Engaging adolescents in reading* (pp. 49–63). Thousand Oaks, CA: Corwin.

Barnes, M.A., Ahmed, Y., Barth, A., & Francis, D.J. (2015). The relation of knowledge–text integration processes and reading comprehension in 7th- to 12th-grade students. *Scientific Studies of Reading*, *19*(4), 253–272. https://doi.org/10.1080/10888438.2015.1022650

Best, R.M., Floyd, R.G., & McNamara, D.S. (2008). Differential competencies contributing to children's comprehension of narrative and expository texts. *Reading Psychology*, *29*(2), 137–164. https://doi.org/10.1080/02702710801963951

Blank, R.K. (2012). *What is the impact of decline in science instructional time in elementary school? Time for elementary instruction has declined, and less time for science is correlated with lower scores on NAEP.* Palo Alto, CA: Noyce Foundation. Retrieved from http://www.csss-science.org/downloads/NAEPElemScienceData.pdf

Brandão, A.C.P., & Oakhill, J. (2005). "How do you know this answer?"—Children's use of text data and general knowledge in story comprehension. *Reading and Writing*, *18*, 687–713. https://doi.org/10.1007/s11145-005-5600-x

Brenner, D., Hiebert, E.H., & Tompkins, R. (2009). How much and what are third graders reading? Reading in core programs. In E.H. Hiebert (Ed.), *Reading more, reading better* (pp. 118–140). New York, NY: Guilford.

Burgoyne, K., Whiteley, H.E., & Hutchinson, J.M. (2013). The role of background knowledge in text comprehension for children learning English as an additional language. *Journal of Research in Reading*, *36*(2), 132–148. https://doi.org/10.1111/j.1467-9817.2011.01493.x

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 in Science Teaching*, *49*(5), 631–658. https://doi.org/10.1002/tea.21015

Cervetti, G.N., & Wright, T.S. (in press). The role of knowledge in understanding and learning from text. In E.B. Moje, P. Afflerbach, P. Enciso & N.K. Lesaux (Eds.), *Handbook of reading research* (Vol. 5). New York, NY: Routledge.

Cervetti, G.N., Wright, T.S., & Hwang, H. (2015, December). *The impact of thematic coherence in reading on the quality of student discussions.* Paper presented at the annual meeting of the Literacy Research Association, Carlsbad, CA.

Cervetti, G.N., Wright, T.S., & Hwang, H. (2016). Conceptual coherence, comprehension, and vocabulary acquisition: A knowledge effect? *Reading and Writing*, *29*(4), 761–779. https://doi.org/10.1007/s11145-016-9628-x

Cook, A.E., & O'Brien, E.J. (2014). Knowledge activation, integration, and validation during narrative text comprehension. *Discourse Processes*, *51*(1/2), 26–49. https://doi.org/10.1080/0163853X.2013.855107

Cromley, J.G., & Azevedo, R. (2007). Testing and refining the direct and inferential mediation model of reading comprehension. *Journal of Educational Psychology*, *99*(2), 311–325. https://doi.org/10.1037/0022-0663.99.2.311

Denton, C.A., Wolters, C.A., York, M.J., Swanson, E., Kulesz, P.A., & Francis, D.J. (2015). Adolescents' use of reading comprehension strategies: Differences related to reading proficiency, grade level, and gender. *Learning and Individual Differences*, *37*, 81–95. https://doi.org/10.1016/j.lindif.2014.11.016

Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education*, *84*(3), 287–312. https://doi.org/10.1002/(SICI)1098-237X(200005)84:3<287:AID-SCE1>3.0.CO;2-A

Duke, N.K., Purcell-Gates, V., Hall, L.A., & Tower, C. (2006). Authentic literacy activities for developing comprehension and writing. *The Reading Teacher*, *60*(4), 344–355. https://doi.org/10.1598/RT.60.4.4

Gasparinatou, A., & Grigoriadou, M. (2013). Exploring the effect of background knowledge and text cohesion on learning from texts in computer science. *Educational Psychology*, *33*(6), 645–670. https://doi.org/10.1080/01443410.2013.790309

Guthrie, J.T., McRae, A., Coddington, C.S., Klauda, S.L., Wigfield, A., & Barbosa, P. (2009). Impacts of comprehensive reading instruction on diverse outcomes of low- and high-

achieving readers. *Journal of Learning Disabilities*, 42(3), 195–214. https://doi.org/10.1177/0022219408331039

Guthrie, J.T., Wigfield, A., Humenick, N.M., Perencevich, K.C., Taboada, A., & Barbosa, P. (2006). Influences of stimulating tasks on reading motivation and comprehension. *The Journal of Educational Research*, 99(4), 232–246. https://doi.org/10.3200/JOER.99.4.232-246

Hansen, J. (1981). The effects of inference training and practice on young children's reading comprehension. *Reading Research Quarterly*, 16(3), 391–417. https://doi.org/10.2307/747409

Hansen, L.E., & Collins, P. (2015). Revisiting the case for narrow reading with English language learners. *Reading Matrix*, 15(2), 137–155.

Hiebert, E.H. (2017). The texts of literacy instruction: Obstacles to or opportunities for educational equity? *Literacy Research: Theory, Method, and Practice*, 66(1), 117–134.

Hwang, H. (2018, April). *Do knowledge and motivation matter? The role of general knowledge and reading motivation in reading achievement in the elementary years*. Paper presented at the annual meeting of the American Educational Research Association, New York, NY.

Jeong, J., Gaffney, J.S., & Choi, J. (2010). Availability and use of informational texts in second-, third-, and fourth-grade classrooms. *Research in the Teaching of English*, 44(4), 435–456.

Kelley, H.M., Siwatu, K.O., Tost, J.R., & Martinez, J. (2015). Culturally familiar tasks on reading performance and self-efficacy of culturally and linguistically diverse students. *Educational Psychology in Practice*, 31(3), 293–313. https://doi.org/10.1080/02667363.2015.1033616

Kintsch, W. (1998). *Comprehension: A paradigm for cognition*. London, UK: Cambridge University Press.

Kuhn, M.R., Schwanenflugel, P.J., Morris, R.D., Morrow, L.M., Woo, D.G., Meisinger, E.B., … Stahl, S.A. (2006). Teaching children to become fluent and automatic readers. *Journal of Literacy Research*, 38(4), 357–387. https://doi.org/10.1207/s15548430jlr3804_1

McElhone, D. (2012). Tell us more: Reading comprehension, engagement, and conceptual press discourse. *Reading Psychology*, 33(6), 525–561. https://doi.org/10.1080/02702711.2011.561655

Mesmer, H.A.E. (2015). Stretching elementary students in complex texts: Why? How? When? In E.H. Hiebert (Ed.), *Teaching stamina and silent reading in the digital-global age* (pp. 81–97). Santa Cruz, CA: TextProject.

Miller, D., & Moss, B. (2013). *No more independent reading without support*. Portsmouth, NH: Heinemann.

Morton, B.A., & Dalton, B. (2007). *Changes in instructional hours in four subjects by public school teachers of grades 1 through 4 (NCES 2007-305)*. Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2007305

National Center to Improve the Tools of Educators. (1996). *Learning to read, reading to learn: Helping children with learning disabilities to succeed*. ERIC Clearinghouse on Disabilities and Gifted Education, Council for Exceptional Children. Retrieved from https://files.eric.ed.gov/fulltext/ED398691.pdf

NGSS Lead States. (2013). *Next Generation Science Standards: For states, by states*. Washington, DC: National Academies Press.

Ozuru, Y., Dempsey, K., & McNamara, D.S. (2009). Prior knowledge, reading skill, and text cohesion in the comprehension of science texts. *Learning and Instruction*, 19(3), 228–242. https://doi.org/10.1016/j.learninstruc.2008.04.003

Palincsar, A.S., & Duke, N.K. (2004). The role of text and text–reader interactions in young children's reading development

and achievement. *The Elementary School Journal*, 105(2), 183–197. https://doi.org/10.1086/428864

Pappas, C.C., Varelas, M., Barry, A., & Rife, A. (2002). Dialogic inquiry around information texts: The role of intertextuality in constructing scientific understandings in urban primary classrooms. *Linguistics and Education*, 13(4), 435–482. https://doi.org/10.1016/S0898-5898(03)00004-4

Peeck, J., Van den Bosch, A.B., & Kreupeling, W.J. (1982). Effect of mobilizing prior knowledge on learning from text. *Journal of Educational Psychology*, 74(5), 771–777. https://doi.org/10.1037/0022-0663.74.5.771

Pentimonti, J.M., Zucker, T.A., & Justice, L.M. (2011). What are preschool teachers reading in their classrooms? *Reading Psychology*, 32(3), 197–236. https://doi.org/10.1080/02702711003604484

Purcell-Gates, V., Duke, N.K., & Martineau, J.A. (2007). Learning to read and write genre-specific text: Roles of authentic experience and explicit teaching. *Reading Research Quarterly*, 42(1), 8–45. https://doi.org/10.1598/RRQ.42.1.1

Rios-Aguilar, C., Kiyama, J.M., Gravitt, M., & Moll, L.C. (2011). Funds of knowledge for the poor and forms of capital for the rich? A capital approach to examining funds of knowledge. *Theory and Research in Education*, 9(2), 163–184.

Romance, N.R., & Vitale, M.R. (2001). Implementing an in-depth expanded science model in elementary schools: Multi-year findings, research issues, and policy implications. *International Journal of Science Education*, 23(4), 373–404. https://doi.org/10.1080/09500690116738

Scull, J., & Winkler, A.M. (2011). *Shifting trends in special education*. New York, NY: Thomas B. Fordham Institute.

So, H.-J., Seah, L.H., & Toh-Heng, H.L. (2010). Designing collaborative knowledge building environments accessible to all learners: Impacts and design challenges. *Computers & Education*, 54(2), 479–490. https://doi.org/10.1016/j.compedu.2009.08.031

Sparks, R.L., Patton, J., & Murdoch, A. (2014). Early reading success and its relationship to reading achievement and reading volume: Replication of "10 years later". *Reading and Writing*, 27(1), 189–211. https://doi.org/10.1007/s11145-013-9439-2

Spires, H.A., & Donley, J. (1998). Prior knowledge activation: Inducing engagement with informational texts. *Journal of Educational Psychology*, 90(2), 249–260. https://doi.org/10.1037/0022-0663.90.2.249

Stanovich, K.E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly*, 21(4), 360–407.

Stanovich, K.E., & Cunningham, A.E. (1993). Where does knowledge come from? Specific associations between print exposure and information acquisition. *Journal of Educational Psychology*, 85(2), 211–229. https://doi.org/10.1037/0022-0663.85.2.211

Taylor, B.M., Peterson, D.S., Pearson, P.D., & Rodriguez, M.C. (2002). Looking inside classrooms: Reflecting on the "how" as well as the "what" in effective reading instruction. *The Reading Teacher*, 56(3), 270–279.

Wilkinson, I.A.G., & Son, E.H. (2011). A dialogic turn in research on learning and teaching to comprehend. In M.L. Kamil, P.D. Pearson, E.B. Moje, & P.P. Afflerbach (Eds.), *Handbook of reading research* (Vol. 4, pp. 359–387). New York, NY: Routledge.

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

LITERATURE CITED

Lincoln Park Zoo. (n.d.) *African lion*. Retrieved from https://www.lpzoo.org/animal/african-lion

Smith, P.A. (2014). Siberian tiger. *Animal Fact Guide*. Retrieved from https://animalfactguide.com/animal-facts/siberian-tiger/

MORE TO EXPLORE

These resources have information on how to develop project-based units of instruction involving informational reading:

- Duke, N.K. (2014). *Inside information: Developing powerful readers and writers of informational text through project-based instruction*. New York, NY: Scholastic.

- Halvorsen, A.-L., & Duke, N.K. (2017). Projects that have been put to the test. *Edutopia*. Retrieved from https://www.edutopia.org/article/projects-have-been-put-test-anne-lise-halvorsen-nell-duke

- Larmer, J., & Mergendoller, J.R. (2010). Seven essentials for project-based learning. *Educational Leadership*, *68*(1), 34–37.