Building Content Knowledge to Boost Comprehension in the Primary Grades

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Abstract

Well-established theoretical models and a body of empirical research elucidate the critical role of content knowledge in comprehending texts. However, the potential of supporting knowledge in service of enhancing linguistic and reading comprehension has been a relatively neglected topic in the science of reading. In this article, we explicate why knowledge building in English Language Arts instruction (i.e., content-rich ELA instruction) can support language and content knowledge, leading to better linguistic and reading comprehension, based on theoretical arguments and empirical studies. In particular, we review the evidence on this claim, paying special attention to experimental trials conducted in K-2 settings. We also share preliminary findings from a novel intervention study testing one instantiation of a widely used content-rich ELA curriculum. Whereas this growing literature base demonstrates evidence of promise, further rigorous trials are needed to examine the efficacy of this integrative approach to teaching reading for understanding.

Keywords: comprehension, content literacy, oral language, vocabulary

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Discussion of the science of reading in popular media outlets tends to focus on enhancing beginning readers' foundational skills through systematic and explicit phonics instruction during the early grades (e.g., Goldstein, 2020). The research community is quick to point out that the science of reading is much broader to include skills related to both decoding and linguistic comprehension, per the Simple View of Reading (Castles, Rastle, & Nation, 2018; Hoover & Tunmer, 2018; Language and Reading Research Consortium [LARRC], 2015). Yet, the national attention paid to foundational skills may inadvertently reinforce narrow conceptualizations of the primary grades as a time to learn to decode words, at the expense of other important learning (Cervetti & Hiebert, 2019). Although automatic decoding plays a central role in reading comprehension, it is necessary but not sufficient for successful comprehension of complex texts (RAND Reading Study Group, 2002). The conversation on the science of reading would be remiss if it did not also include careful consideration of how to simultaneously develop linguistic comprehension during the early grades.

The "C" in the Simple View of Reading equation (R = D X C) denotes *linguistic comprehension* (also referred to as language or listening comprehension; Hoover & Tunmer, 2018; LARRC, 2017) and makes an indispensable contribution to reading comprehension. When considering the skills that influence "C," well informed primary grade educators point to the critical role of language, which includes understanding the meanings of words (i.e., vocabulary) and the ways that words and sentences are combined to reflect written discourse. Indeed, a substantial body of research indicates that early language development underlies and supports comprehension ability (e.g., Kendeou et al., 2009; Storch & Whitehurst, 2002; LARRC, 2015; LARRC, Jiang, & Logan, 2019; Scarborough, 2009; Vellutino, Tunmer, Jaccard, & Chen, 2007).

Young children develop language through frequent, fine-tuned conversational interactions with adults who provide them with exposure to sophisticated vocabulary and advanced language models (Landry, Smith, & Swank, 2006; Vasilyeva & Waterfall, 2011). In kindergarten through second grade (K-2) settings, the use of interactive read alouds to explicitly teach academic vocabulary and other language skills (i.e., inferential, narrative) is a recommended practice (Foorman et al., 2016) that is frequently included in popular English Language Arts (ELA) reading programs (e.g., Wright & Neuman, 2013).

However, the other key contributor to linguistic comprehension ("C") is often forgotten, namely the knowledge that a person brings to a text, and theoretical models of reading comprehension consistently showcase its essential role in reading comprehension (Cromley & Azevedo, 2007; Kintsch, 2013; Stafura & Perfetti, 2017). Yet, in practice, knowledge has been largely relegated to *activation* of the knowledge students already have instead of systematically *building* new content knowledge. Building content knowledge (i.e., knowledge related to the natural and social world; Connor et al., 2017; Kim et al., 2020) to enhance linguistic comprehension is just beginning to gain traction in the national conversation (Wexler, 2019). The accumulated science of reading clearly points to the necessity of building content knowledge, and there is a growing evidence base on the science of teaching reading through integrated literacy and knowledge-building supports (e.g., Cervetti, Wright, & Hwang, 2016; Connor et al., 2017; Guthrie, Anderson, Alao, & Rinehart, 1999; Kim et al., 2020; Neuman & Kaefer, 2018; Vitale & Romance, 2012; Williams et al., 2016; Wright & Gotwals, 2017). In current U.S. practice in the primary grades across many large districts, this has translated into explicitly building both language and knowledge through the use of content-rich English Language Arts instruction.

The central claim of this article is that content-rich ELA instruction in the primary grades can cultivate the abilities that influence linguistic comprehension (i.e., language and knowledge). We first provide a rationale for the importance of building students' content knowledge in the primary grades and how this knowledge-building support relates to language, knowledge, and comprehension. Next, we provide a review of the research that describes the effects of integrating literacy and content-area instruction on vocabulary and comprehension outcomes, paying special attention to rigorous studies in K-2 settings that examine content-rich English Language Arts (ELA) approaches or curricula. We then report the preliminary results from an ongoing longitudinal research study examining the efficacy of a widely used content-rich ELA curriculum on kindergarten students' language and knowledge outcomes. Finally, we call for future directions to further grow the evidence base on integrating knowledge-building into ELA instruction.

The Role of Content Knowledge in Comprehension

Although reading serves as a foundation for content-area learning, it is also true that science and social studies content knowledge is a malleable factor driving individual differences in later reading comprehension outcomes (Cervetti & Wright, 2020). Students' content knowledge on a topic can help them to better understand a text about that topic. Schema theorists, for example, have long noted that "poor readers are likely to have gaps in knowledge…the less the reader knows, the less the reader comprehends" (Anderson & Pearson, 1984, p. 286). Why might this be the case? As we read or listen to a text read aloud, we are tasked with connecting the ideas across sentences in ways that build an understanding of the author's message, and it is content knowledge that guides how ideas can be connected to one another (i.e., constructing the textbase in the Construction-Integration model of text

comprehension; Kintsch, 1998; 2013). Content knowledge also supports making inferences about the missing information in texts (Ozuru, Dempsey, & McNamara, 2009). Authors typically omit information with the assumption that readers approach a text with some knowledge of the topic; otherwise, reading would be exceedingly tedious and boring if authors included all information needed to fully understand a given text. Thus, the gap-filling process of content knowledge for missing information in texts is crucial in comprehending what the text says (Kintsch, 2013). Moreover, to achieve a more advanced level of comprehension (e.g., critically examining author's point of view), students need to integrate the textbase with their pre-existing content knowledge to create a mental model about the overall idea of a text (i.e., the situation model in the Construction-Integration model of text comprehension; Kintsch, 1998, 2013; Pearson & Cervetti, 2015). This integration process is better facilitated when students have stronger content knowledge (Cervetti & Wright, 2020).

Knowledge and Learning

Content knowledge is important not only in comprehending a text but also in learning from it (i.e., gaining new knowledge). Knowledge is expanded when it is integrated with the textbase (i.e., constructing the situation model), because it is how new information learned from text is stored in a long-term memory (Kintsch, 1998, 2013). Moreover, content knowledge also aids in the processing of information from a text in memory (Willingham, 2017). Content knowledge enables information to be chunked or stored together in working memory, freeing up space for other information to be understood or learned from the text (see Willingham, 2006).

Because students will be exposed to increasing amounts of informational texts across content areas as they progress in their academic careers, having broad content knowledge can provide them with an advantage (Kintsch, 2009; Stanovich & Cunningham, 1993). Students with

broad content knowledge are more likely to have familiarity with the range of science or social studies topics that they will encounter in texts. Indeed, it has been observed that having broad knowledge about the social and/or natural world predicts reading comprehension in general (Grissmer, Grimm, Aiyer, Murrah, & Steele, 2010; Hwang, 2019; Hwang & Duke, 2020). Moreover, when students possess broad content knowledge, it is likely that they have developed complex and coherent knowledge structures around multiple topics in science and social studies domains (i.e., deeper conceptual understanding in domains; Gelman & Kalish, 2007), which can facilitate the process of retrieving relevant information and integrating old and new information (Anderson & Pearson, 1984). Given the potential of broad knowledge, cultivating students' content knowledge should go beyond a specific topic related to a text (e.g., Kim et al., 2020). Because reading comprehension tests in later grades tend to require knowledge of science and social studies topics, broad content knowledge that is built systematically over time, starting with the earliest grades, is necessary (Hwang, in press).

Knowledge and Language

Knowledge is intimately related to language. In particular, theorists have long thought of vocabulary as being the "tip of the iceberg" of a person's conceptual knowledge (e.g., Anderson & Freebody, 1981). Thus, it is reasonable to surmise that building knowledge can also accelerate language skills. Students who are knowledgeable about plants, for example, are likely to know meanings of words such as stems and roots. Indeed, Cervetti et al. (2016) demonstrated that cultivating conceptual knowledge can facilitate students' incidental word learning related to a concept. This exposure to related words around concepts provides students with wider and stronger semantic networks to draw upon when listening to or reading a text (Willingham, 2006). In addition to incidental word learning, *explicitly* building students' language skills within the

context of teaching content knowledge is also a sound practice. Some intervention studies have explicitly taught meanings of words connected to concepts, as well as relations among the words, and have demonstrated positive effects on vocabulary outcomes in early grades (e.g., Gonzalez et al., 2011; Kim et al., 2020; Neuman et al., 2011; Neuman & Kaefer, 2018). Enhancing vocabulary and content knowledge simultaneously through content-rich ELA instruction can have a synergetic, positive effect on reading development because knowledge and vocabulary work together to help a reader to successfully construct meaning from text (Stahl, Hare, Sinatra, & Gregory, 1991).

Building Language and Knowledge in the Context of Content-Rich ELA Instruction

Reading instruction is traditionally disconnected from knowledge building in science and social studies (Palincsar & Duke, 2004). At the same time, content-area learning currently receives inadequate instructional time in the primary grades (Cox, Parmer, Strizek, & Thomas, 2016), likely due to the fact that reading became a driving national focus of federal initiatives and instruction in the early 2000s and forward (e.g., Reading First). Given the current school day schedule, coupled with guidance to systematically build knowledge (e.g., ELA Common Core State Standards), it is no surprise that there has been a recent upsurge in the development and use of content-rich ELA curricula in the primary grades. In addition, the process of knowledge development is cumulative and exponential (Neuman & Roskos, 2012). Thus, it makes sense to infuse content-area learning into literacy instruction where possible. Because the primary avenue through which young children acquire content knowledge is through oral language, many of these programs involve reading aloud to children and explicitly teaching academic vocabulary words that aid in the comprehension of texts, a key strategy endorsed by the summary of the extant literature on building reading for understanding in the primary grades (Foorman et al.,

2016). Employing ELA instruction to supplement existing science and social studies teaching by systematically teaching content knowledge may be a means for reducing later gaps in reading comprehension outcomes.

What Research Says About Integrating Literacy and Content-Area Instruction

We have established that knowledge plays an important role in comprehension development and that language skills that underlie reading can be strengthened within the context of teaching content knowledge. We now systematically review the studies conducted to date to understand what research says about the effectiveness of integrating literacy and content-area instruction in the early grades. Because the testing of integrated literacy and knowledge-building approaches is a growing area of inquiry and there are relatively few experimental studies in K-2 settings, and even fewer that test content-rich ELA instruction, we briefly review the strength of the effects in the literature base more broadly, in K-5 elementary school settings. We then narrow our focus to closely examine the handful of (quasi)experimental studies conducted in K-2 settings that have employed rigorous methodological designs.

Effects of Integrated Literacy and Content-Area Instruction in K-5 Settings

After a systematic search of the extant literature, we identified 31 (quasi) experimental studies from peer-reviewed journals or dissertations that appeared in search engines by the end of March 2020 (Hwang, Cabell, & Joyner, in preparation). These studies compared the vocabulary and/or comprehension outcomes of elementary-aged students (i.e., K-5) who received integrated instruction between literacy and content areas (i.e., treatment) with those of students who received traditional literacy and content-area instruction separately (i.e., control or comparison group). Preliminary results of the meta-analysis demonstrated that large and statistically significant average effect sizes for vocabulary ($g = 1.48$, $p < .001$, $k = 30$) and comprehension

outcomes ($g = 0.87$, $p < .001$, $k = 145$). The effect size was considerably larger for linguistic comprehension outcomes ($g = 1.39$, $p < .001$, $k = 52$) than reading comprehension ($g = 0.34$, $p < .001$, $k = 46$). In addition, a supplementary analysis revealed that integrated instruction has a large and statistically significant average effect size for content knowledge outcomes ($g = 1.30$, $p < .001$, $k = 51$). In summary, the meta-analysis shows that though the number of studies conducted in this area is relatively small, these studies suggest a promising effect on students' vocabulary and comprehension while, at the same time, building content knowledge.

Effects of Content-Rich ELA Instruction in K-2 Settings

When considering the studies that specifically examined content-rich ELA approaches in K-2 settings, there were 4 studies in the larger corpus that met a rigorous standard for methodological design (informed by the What Works Clearinghouse Standards Handbook [IES, 2017]). We discuss the findings from these studies, and then describe common practices across these studies. Connor et al. (2017) implemented the 12-week *Content-Area Literacy Instruction* program that supplemented literacy instruction to build science and social studies knowledge in kindergarten through fourth-grade students. They found the positive effect of the program on proximal science and social studies knowledge outcomes but did not detect any effect on standardized comprehension and vocabulary outcomes in K-2 grades. The other three studies focused on cultivating science knowledge in service of comprehension and/or vocabulary development. Neuman and Kaefer (2018) found positive effects of implementing the *World of Words* program that supplemented literacy instruction for 20 weeks; prekindergarten and kindergarten students who received the intervention outperformed those who did not on proximal vocabulary and science knowledge measures, but there were no significant effects on standardized vocabulary outcomes. Vitale and Romance (2012) implemented the longest

intervention among the four studies. They demonstrated that first- and second-grade students who received Science IDEAS instruction (conducted as supplement to literacy instruction) during one school year did better on standardized reading comprehension and science knowledge measures than those who did not. The fourth study showcased the program developed and tested by Kim et al. (2020), the Model of Reading Engagement (MORE), that replaced traditional literacy instruction (for 10 days). They reported positive effects of the program on proximal vocabulary and linguistic comprehension, as well as on standardized reading comprehension measures in first grade students. Caution must be exercised in drawing conclusions based on the small number of studies, but it is worth mentioning that the advantage of content-rich ELA programs in supporting students' comprehension was observed in the lengthiest program (Vitale & Romance, 2012) and the program that replaced traditional literacy instruction, despite its brief implementation (Kim et al., 2020).

In terms of teaching strategies, the ELA instructional approaches represented by the four studies were characterized by instructional frameworks organized around logical sequencing of content knowledge. Sessions systematically progressed toward teaching students increasingly complex ideas, building on ideas learned from previous sessions. For example, teachers in the intervention by Kim et al. (2020) read aloud two books about polar bears in earlier classes, then in later classes, they involved students in researching different Arctic animals to support them to become Arctic animal experts. Texts were presented in conceptually coherent sets. For example, teachers in the intervention by Neuman and Kaefer (2018) read aloud five books that were conceptually connected to one another (e.g., parts of plants). The text set consisted of predictable, narrative, and informational text. Students were involved in reading, writing, discussion, and/or hands-on activities for the purpose of learning content in a cumulative way.

For example, in the economic unit about money and needs/wants, first-grade students in Connor et al. (2017) planned a business to sell snacks (hands-on activities) based on their reading about the economic concepts. The planning also involved students in writing and discussing a business plan. This characteristic of leveraging literacy instruction to cumulatively learn content is notably different from traditional ELA instruction, in which sessions are sequenced based on literacy skill progressions, regardless of content (e.g., reading about alpaca to identify main ideas, then reading about the sun to practice comprehension monitoring). Moreover, three studies (Kim et al., 2020; Neuman & Kaefer, 2018; Vitale & Romance, 2012) explicitly taught words connected to concepts and relations among the words. For example, teachers in the intervention by Neuman and Kaefer (2018) explicitly explained meanings of words (e.g., camel, scorpion) and their relations to higher taxonomic categories (e.g., animals in the desert). In addition to the explicit explanation, teachers in the interventions by Kim et al. (2020) and Vitale and Romance (2012) utilized concept maps to visually show the relations among conceptually connected words (see the supplementary materials in Kim et al., 2020).

In summary, this small but growing literature base demonstrates evidence of promise, but further rigorous trials are needed to examine the efficacy of content-rich ELA instruction in the primary grades. There are a handful of ELA curricula in wide use in the United States that have received high quality ratings with regard to knowledge building components (see https://www.edreports.org). These curricula require rigorous testing to ascertain whether they actually meet the needs of students by building language and content knowledge.

A Recent Evaluation of a Content-Rich ELA Program in Kindergarten Classrooms

We now turn our attention to a test of a widely used content-rich ELA program that employs knowledge building as the context to build language skills and content knowledge

simultaneously in the primary grades. Our team conducted two randomized controlled trials in kindergarten of the *Core Knowledge Language Arts: Knowledge Strand* (CKLA: Knowledge; Core Knowledge Foundation & Amplify Education, Inc., 2017), whose instructional approach aligns with the key practices found in the extant literature. Specifically, CKLA: Knowledge employs read alouds of coherent text sets, systematically ordered to sequentially build broad content knowledge in science and social studies topics, while at the same time explicitly building vocabulary and other language skills through discussion and application of learning. In many ways, the CKLA: Knowledge is a specific instantiation of a knowledge-based curriculum designed to improve linguistic comprehension, per the simple view of reading. (The parallel CKLA: Skills Strand focuses on decoding.)

Two trials, each conducted in a large urban U.S. school district, were represented in this ongoing longitudinal study (Cabell, White, Kim, Hwang, & Gale, 2019). Both trials followed identical procedures (i.e., systematic replication), in 2017-2018 and 2018-2019, respectively. In the first trial, 23 schools in a district in a mid-Atlantic state were randomly assigned to either the treatment (n = 11) or business-as-usual control condition (n = 12). In the second trial, 24 schools in a district in a Southern state were randomly assigned to either the treatment (n = 12) or the business-as-usual control condition (n=12). Kindergarten teachers (n = 65) in treatment schools implemented CKLA: Knowledge for one semester. Students (n = 1218) were individually tested in the fall (prior to randomization of schools) and spring (post intervention) on a battery of proximal and standardized assessments of language and knowledge. Proximal measures were created by researchers and examined whether children learned the words and knowledge they were taught in the curriculum. Standardized measures gauged students' general learning in the

areas of receptive vocabulary, expressive vocabulary, linguistic comprehension, and content knowledge in science and social studies.

Preliminary analyses for both trials involved multilevel modeling, with students nested within schools. To increase precision across the effect size estimates, we meta-analyzed the standardized results across the trials. In summary, findings indicated significant main effects on proximal measures of vocabulary (average ES = 0.55), science knowledge (average ES = 0.26) and social studies knowledge (average ES = 0.97), as well as standardized measures of expressive vocabulary (average ES = .09) and science knowledge (average ES = 0.12). Significant main effects were not found for standardized measures of receptive vocabulary, linguistic comprehension, and social studies knowledge.

Findings for the proximal measures were in keeping with the larger meta-analysis of previous studies, as well as the K-2 content-rich ELA studies specifically, in terms of the positive effects of the curriculum on both taught vocabulary words (Kim et al., 2020; Neuman & Kaefer, 2018) and content knowledge (Connor et al., 2017; Neuman & Kaefer, 2018; Vitale & Romance, 2012). Differences in the magnitude of effects between the proximal science and social studies knowledge outcomes likely reflect the topics being assessed. Specifically, for the proximal science measure, students were asked to tell everything they knew about plants (a common kindergarten topic), whereas for the social studies measure, students were asked about Native Americans (a topic only taught in the treatment group).

Although modest, the significant impact on standardized measures of language and science knowledge stand out because relatively few interventions actually show transfer to more generalized learning as measured via a standardized assessment (e.g., Elleman, Lindo, Morphy, & Compton, 2009). Indeed, large-scale randomized controlled trials typically demonstrate an

average effect size of 0.01 on kindergarten outcomes and 0.01 on language outcomes across grades (Lortie-Forgues & Inglis, 2019).

Yet, significant findings did not extend to standardized measures of receptive vocabulary, linguistic comprehension, or social studies knowledge. Although the receptive and expressive modalities of vocabulary generally reflect a single construct (Lonigan & Milburn, 2017), the extant literature documents that some read-aloud interventions have a larger impact on a single modality (e.g., Gonzalez et al., 2011; Mol, Bus, de Jong, & Smeets, 2008). With regard to linguistic comprehension, this nonsignificant finding is in keeping with Connor et al.'s (2017) study, and it may be the case that relationship between the intervention and comprehension is indirect, mediated through vocabulary or knowledge (e.g., LARRC et al., 2019). One reason for differences in standardized science and social studies measures could be that treatment teachers felt more comfortable teaching science rather than social studies, demonstrated by survey results of the specific topics covered in the curriculum.

In sum, the results of this work indicate that early content-rich ELA instruction—involving students interacting with complex, systematically organized texts—can lead to enhanced learning in vocabulary as well as content knowledge. It is important to note that this work is ongoing, and the second trial continued implementation into first grade, spanning two academic years. This type of longitudinal investigation is needed to more fully understand the impact of a content-rich ELA program on linguistic comprehension over time, as well as eventual impact on reading comprehension.

Future Directions

The evidence base is this area is growing, and considerably more work will need to be done to understand the impact of content-rich ELA programs on comprehension in the primary

grades. Not surprisingly, we advocate for more experimental research in this area. With the number of content-rich ELA programs increasing, evaluations of these programs are necessary. Moreover, language and knowledge take time to build and are not only cumulative but exponential in their growth (Neuman, 2006). Thus, longitudinal studies that test programs implemented for multiple years can ascertain long-term impact on linguistic comprehension to better understand the extent to which early and sustained knowledge building matters for later reading comprehension.

There are many unanswered questions, such as the content of instruction, how it should be structured, and its effects on different groups of students. Whose knowledge we are teaching is a highly politicized concern, and research does not clearly delineate what knowledge is best to teach, nor is it clear whether instruction should prioritize a broad set of topics systematically built over time or deeper instruction on a smaller set of topics. However, adjusting instruction to be culturally relevant for students can support their engagement and development in reading (see Au, 1980), and successful instruction often builds on students' prior knowledge and experiences (e.g., Souto-Manning, Llerena, Martell, Maguire, & Arce-Boardman, 2018). There are also differences among effective integrated approaches with regard to explicit instruction in comprehension strategies, with evidence that knowledge-building and strategy instruction can be combined to enhance comprehension without diminishing its impact on knowledge (Elleman & Compton, 2017; Williams et al., 2016). In addition, we have little understanding of the effects of content-rich ELA instruction on students who are English learners (c.f., Neuman & Kaefer, 2018) or how to tailor knowledge-building support for this population (e.g., Lesaux & Harris, 2015). Given the few programs which have been tested thus far, we expect that new approaches will be developed that take advantage of the science of reading in this area. Most content-rich

ELA programs that are currently used in K-2 settings are not designed to replace science and social studies instruction but rather serve to complement existing content-area teaching. This could result in disjointed knowledge building for students across the day or replacement of content areas that was not intended by curriculum developers. Programs are needed that align ELA and the content areas for seamless learning, addressing both ELA and content-area standards, and these integrative programs should be rigorously tested.

Conclusion

The simple view of reading (R = D X C) serves as a useful lens to understand the malleable factors that improve reading comprehension. In this article, our aim was to help the field transcend narrow conceptualizations of the science of reading that often view linguistic comprehension (C) as synonymous with building language skills. Indeed, strengthening students' language skills, including vocabulary, at the earliest grade levels is critical for reading for understanding (Foorman et al., 2016), but it is only part of the picture. Building content knowledge is also essential, since the main determinant of understanding a text is how much knowledge a reader brings to reading (Anderson & Pearson, 1984). In the context of knowledge building, language and knowledge can grow together to have a synergistic effect on linguistic comprehension and eventual reading comprehension. A relatively small but robust evidence base demonstrates that content-rich ELA instruction can serve as an important context for simultaneously building both language and knowledge. As these approaches are increasingly used across the U.S., further research is needed to strengthen the science of teaching reading in this area.

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