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Common Core State Standards and Text Complexity: An Invitation to Learn Language in STEM Disciplines using a Range of Quality Literature

Rebecca M. Giles, Ph.D. & Leah Kinniburgh, Ph.D.

Abstract — The Common Core State Standards (CCSS) emphasize literacy learning within history/social studies, science, and technical subjects making students’ reading, writing, and language development every teacher’s concern, regardless of the discipline being taught. Books related to science, technology, engineering, and mathematics (STEM) can enhance students’ knowledge of key terms and concepts as they are revealed in authentic contexts. Students who often struggle harder to understand advanced vocabulary embedded in stories or in difficult, yet interestingly presented nonfiction gain an increased print vocabulary by reading quality STEM-aligned literature selections that exhibit the characteristics of complexity and richness of language advocated by CCSS. Effectively pre-teaching vocabulary and scaffolding students’ use of self-regulation strategies to discover word meanings will increase comprehension and content literacy as well as content learning.

“Hey, I learned a new word today.” This greeting from my oldest son Jay as he arrives at our van after school is one of my favorite. That he can receive true joy from such a simple but significant occurrence never ceases to amaze me. It is not surprising, however, that this declaration is made while he’s holding *Harry Potter and the Order of Phoenix*, a book that includes vocabulary that is genuinely magical. It is worth noting that the words revealed following my fourth grader’s spontaneous outbursts are never found on the weekly list assigned by his teacher. Rather, the new words he’s so anxious to share were unearthed during his independent reading. Even his reading choices with questionable

literary merit often yield wordy treasures. For example, “synopsis” was acquired while perusing *Poptropica: The Official Guide*. Because they are more strongly motivated to discover meanings of words found in their self-selected books read for pleasure than in their textbooks, students often struggle harder to understand advanced vocabulary embedded in stories or complex, yet interestingly presented nonfiction. The Common Core State Standards place an increased emphasis on literacy within history/social studies, science, and technical subjects, making students’ reading, writing, and language development every teacher’s concern, regardless of the discipline being taught. Imagine the possibilities if the science, technology, engineering, and mathematics (STEM) curriculum was supplemented with STEM-aligned literature selections to enhance students’ knowledge of key terms and concepts revealed in authentic contexts (Reed, 2012) while reading complex texts.

THE IMPORTANCE OF TEXT COMPLEXITY

Increasing the complexity of texts students read is a key element in improving reading comprehension (Student Achievement Partners, 2012). As children progress in reading skills, they develop the capacity to read more complex texts (Benjamin & Schwanenflugel, 2010). Reading complex texts in the upper-elementary grades builds a necessary foundation for students’ reading and understanding of increasingly complex texts on their own in middle and high school (Hiebert, 2011). Likewise, early exposure to a wide range of text types – stories, dramas, poetry, and literary nonfiction, as well as historical, scientific, and technical texts – increases familiarity with and confidence towards various genres in subsequent grades. Young adolescents exposed to a variety of complex texts, which generally have heavier comprehension requirements due to unfamiliar vocabulary and longer sentences (Benjamin & Schwanenflugel, 2010; O’Connor et al., 2002), throughout elementary school will be well-prepared to

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meet the multi-faceted literacy tasks specified in the Common Core State Standards (see Figure 1) for grades 6-12. As a result, integrating a diversity of complex, yet intriguing literature selections across disciplines becomes a priority in all classrooms and an effective means for expanding students' oral and print vocabularies.

Figure 1 - Common Core College and Career Readiness Anchor Standards for Reading (K-12)

Key Ideas and Details
<p><i>CCSS.ELA-Literacy.CCRA.R.1</i> Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.</p>
<p><i>CCSS.ELA-Literacy.CCRA.R.2</i> - Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.</p>
<p><i>CCSS.ELA-Literacy.CCRA.R.3</i> - Analyze how and why individuals, events, or ideas develop and interact over the course of a text.</p>
Craft and Structure
<p><i>CCSS.ELA-Literacy.CCRA.R.4</i> - Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.</p>
<p><i>CCSS.ELA-Literacy.CCRA.R.5</i> - Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.</p>
<p><i>CCSS.ELA-Literacy.CCRA.R.6</i> - Assess how point of view or purpose shapes the content and style of a text.</p>
Integration of Knowledge and Ideas
<p><i>CCSS.ELA-Literacy.CCRA.R.7</i> - Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.</p>
<p><i>CCSS.ELA-Literacy.CCRA.R.8</i> - Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.</p>
<p><i>CCSS.ELA-Literacy.CCRA.R.9</i> - Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.</p>
Range of Reading and Level of Text Complexity
<p><i>CCSS.ELA-Literacy.CCRA.R.10</i> - Read and comprehend complex literary and informational texts independently and proficiently.</p>

Text complexity involves the assessment of four qualitative factors—1) structure, 2) language conventionality and clarity, 3) knowledge demands, and 4) levels of meaning (literary texts) or purpose (informational texts). These qualitative factors seem to be particularly important when evaluating narrative fiction (Hiebert, 2011). Few, if any, authentic texts will be at the

low or high ends on all of the dimensions, and some are better suited to either literary or informational texts (Nelson, Perfetti, Liben, & Liben, 2012). The aspect of text complexity most concerned with vocabulary development is *Language Conventionality and Clarity*.

Texts that rely on figurative, ironic, ambiguous, purposefully misleading, archaic, or otherwise unfamiliar language (such as general academic or domain-specific vocabulary) are naturally more complex. Two text features typically quantified to determine complexity are the average number of words in sentences and the vocabulary (Hiebert, 2012). Short sentences, however, are not necessarily easier to read than long sentences. Further, the repetition of a rare or unfamiliar word, which can actually aid comprehension and vocabulary learning, may result in an overestimated level of difficulty (Hiebert, 2011). This is particularly true in informational texts due to a lack of synonyms for content-specific words, but may also be an issue in stories containing unusual character or place names. While readability formulas can place a book within a particular grade-level span, the real work remains in determining the book's suitability in relation to the reader. Books written in relatively low-level language may contain complicated issues or mature themes which make them inappropriate choices while a reader's interest may account for their ability to enjoy a text perceived as too difficult.

SELECTING STEM LITERATURE

High-level language, even if accurately assessed, does not necessarily coincide with high-quality literature. Selecting texts for student reading should not only depend on text complexity but also on considerations of quality. The Common Core State Standards emphasize that

[t]o become college and career ready, students must grapple with works of exceptional craft and thought whose range extends across genres, cultures, and centuries. Such works offer profound insights into the human condition and serve as models for students' own thinking and writing. (p. 35)

Fortunately, there are numerous sources available to assist content area teachers in identifying quality STEM related texts. Books recognized as the best in their field by various professional organizations are an excellent resource (see Figure 2). Many of these recent award winners exhibit characteristics of complexity and richness of language. For example, the 2007 *Orbus Pictus* award winner for excellence in the writing of nonfiction for children, *Quest for the Tree Kangaroo: An Expedition to the Cloud Forest of New Guinea* (Houghton Mifflin, 2006) by Sy Montgomery with photographs by Nic Bishop, also appears on CCSS list of texts illustrating the complexity, quality, and range of student reading for grades 4-5 in the informational text category. Other notable selections for young adolescent readers by the publishing duo of Montgomery and Bishop include

Kakapo Rescue: Saving the World's Strangest Parrot (Houghton Mifflin, 2011), *The Tarantula Scientist* (Houghton Mifflin, 2005), and *The Snake Scientist* (Houghton Mifflin, 1999). The three books written and illustrated by Sophie Webb, which are actually modified journals from different research projects, are also viable options. Webb's most recent addition, *Far from Shore: Chronicle of an Open Ocean Voyage* (Houghton Mifflin, 2011), was even mentioned in the December 2, 2011 issue of *Science* magazine as a worthy account of a National Oceanic and Atmospheric Administration research cruise in the eastern tropical Pacific appropriate for middle grade readers. Jean Craighead George's many nature books, including Newbery Award Winner *Julie of the Wolves* (HarperCollins, 2003), delve deeply into a specific ecosystem through the life experiences of compelling characters while the 2013 Newbery Medal winner, *The One and Only Ivan* by Katherine Applegate (HarperCollins, 2012), recounts the fascinating life of a gorilla in captivity through the gorilla's own distinct narrative voice. While the choices for texts highlighting issues in Biology, Ecology and Zoology abound, so do those that emphasize technological advances, like *Something Out of Nothing: Marie Curie and Radium* by Carla Kilough McClafferty (Farrar Straus Giroux, 2006) as well as engineering marvels, such as *Brooklyn Bridge* by Lynn Curlee (Anthemum, 2001). Such books and many others can be used to compliment the list of grade-range texts illustrative of complexity, quality, and range found in CCSS Appendix B as content area resources for learning and retaining new word and concepts.

Figure 2 - Sources for STEM Aligned Texts

Excellence in Nonfiction for Young Adults – Awarded by the American Library Association Young Adult Library Services Associations for the best nonfiction book published for young adults (ages 12-18) during a November 1 – October 31 publishing year.

Outstanding Books for the College Bound and Lifelong Learners – Compiled by the American Library Association Young Adult Library Services Associations to provide reading recommendations in various categories, including science and technology, to students of all ages who plan to continue their education beyond high school.

Robert F. Sibert Informational Book Award – Awarded annually since 2001 by the Association of Library Service to Children to the author(s) and illustrator(s) of the most distinguished informational book published in the United States in English during the preceding year.

Outstanding Science Trade Book Award – Presented by the National Science Teachers Association

Orbus Pictus Award – Awarded by the National Council of Teachers of English for the best nonfiction picture book of the year.

Teachers must employ professional judgment to appropriately match texts to an individual or class of students. Numerous considerations go into such

matching. Of particular importance is student motivation. Students who have a great deal of interest in the content are also likely to handle more complex texts. Scaffolding their learning by effectively teaching vocabulary increases comprehension and content literacy as well as content learning.

VOCABULARY INSTRUCTION

Print vocabulary is more difficult to attain than oral vocabulary because the words, figures of speech, syntax, and structures of text are more complex and obscure than those of spoken language (Moats, 2004). In content areas in which the text may be more technical and abstract, insufficient vocabulary knowledge may be especially problematic. Additionally, a word's meaning may vary based on its subject area context (such as meter in English and mathematics) presenting further challenges. As a result, teaching vocabulary involves using a combination of instructional strategies along with providing repeated exposure to unknown words in a variety of contexts (National Institute for Literacy, 2007).

In learning vocabulary, prior knowledge plays a crucial role. Consequently, teachers need to be aware of the students' level of word knowledge as related to the concept it represents. Alvermann, Gillis, and Phelps (2013), call these *word learning tasks*. They include "(1) known word/known concept, (2) new word/known concept, (3) known word/new concept, and (4) new word/new concept" (p. 244). The first three tasks include a "familiarity" with either the word, the concept, or both. The students have either heard the word, know the concept the word implies, or know the word and the concept. Unique words in narratives that students encounter as they read, usually fit into one of these three categories (Hiebert, n.d.). The fourth task, however, is the most difficult because the word is new and the students are unfamiliar with the concept. These are the unique/difficult words from informational texts and textbooks (Hiebert, n.d.). Teachers must pre-teach these words because the students are developing new concepts and new vocabulary within the overall schema of the topic being covered in the content area (Alvermann et al, 2013).

In selecting the words to pre-teach, Bryant, et al., (2003) offer the following guidelines to teachers:

1. Importance of the word for understanding the text;
2. Students' prior knowledge of the word and the concept to which it relates;
3. The existence of multiple meanings of the word;
4. Opportunities for grouping words together to enhance understanding a concept.

Research has shown that repeated exposure to unknown words and their meanings produces the best results for vocabulary learning (Bryant, et al., 2003; Medo & Ryder, 1993). Once teachers have identified the specific words that are to be pre-taught, they should then consider ways

to make repeated exposure to the words and their meanings motivating and enjoyable for the students (National Institute for Literacy, 2007). One option is to provide literature selections containing the words. Greenwood and Flanigan (2007) stress that if repeated, meaningful encounters with difficult vocabulary are essential for word learning, then teaching students how to use context clues may be effective in increasing word identification and retention of word meaning.

USING CONTEXT CLUES

Encountering new terms and domain-specific words and phrases in context of complex text, whether it is literary or technical, provides a valuable opportunity for using context as a clue to their meaning. Context clues can contribute to the reader's understanding of subject-specific words and phrases or clarify the meaning of multiple-meaning words and phrases. Once the meaning of a specific word is known, it will contribute to one's understanding of figurative language (e.g., similes, metaphor), word relationships, and nuances in language, such as the relationship between particular words (e.g., synonyms, antonyms, homographs), thus, increasing the student's understanding of the text as a whole. The context redefinition strategy can be used to assist students in using context clues.

The context redefinition strategy (Bean, 1981; Cunningham, Cunningham, & Arthur, 1981) is unconsciously used by proficient readers to predict the meaning of unknown words and then using context to confirm their predications. It consists of five steps:

1. Select about four key words from a story or text chapter.
2. List or project these on the board with a blank space for the students' predictions.
3. Have students predict what they think each word means; write their predictions verbatim, and then vote on the most plausible prediction.
4. Have students verify their predictions.
5. After reading, have students edit or redefine their initial predictions to reflect contextual meaning. Students may choose to copy these definitions in their own glossaries. (Shanker & Cockrum, 2009, p.154).

This context redefinition strategy is used for introducing and teaching new vocabulary words. It is not used for reinforcement of words the students have been exposed to previously (Wiesendanger, 2001). Once the words have been introduced, read in context, and the predictions verified or edited, other activities are included in instruction to provide students with multiple encounters with their new words.

Vocabulary self-collections are an excellent way for students to document and maintain learned vocabulary, as well as words they want to learn. Self-collection uses student interest and world knowledge to enhance vocabulary growth through personal connections. Once

collected, these words should be revisited and used for authentic tasks and on a regular basis in their writing (Ruddle & Shearer, 2002).

CONCLUSION

Rather than adding literacy tasks to STEM content, we must discover how to teach the same material in new ways that embrace reading, writing, and vocabulary skills (Reed, 2012). As educators, we need to encourage the excitement of exploring words and their significance in a meaningful context. Simply memorizing words and their definitions does a great disservice to our students and their potential. Learning language through more creative, thoughtful, and engaging approaches, such as the integration of literature to provide an authentic context for vocabulary, will result in more creative and thoughtful scientists, engineers, and mathematicians. Using a wide range of texts illustrative of complexity, quality, and range in STEM disciplines to meet the challenging literacy tasks specified in the Common Core State Standards increases students' college and career readiness in terms of their reading comprehension abilities as well as their content knowledge. Coupling quality literary examples of complex texts with direct, explicit vocabulary instruction further enhances the skills and understandings expected of a literate twenty-first century citizen in the classroom or workplace.

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