

CONTENT-RICH LITERACY IN SCIENCE

INTRODUCTION

The discipline of science has content that is subject-matter specific and requires learners to utilize specific literacy strategies unique to the discipline (International Reading Association, 2012). Content teachers play a vital role in using appropriate literacy tools to build students' knowledge for learning and reasoning within that discipline (International Reading Association, 2012; Pearson, Moje, & Greenleaf, 2010). A scientifically literate populace capable of building a better society has been the call to action in science education reform for the last few decades (Gillis & MacDougall, 2007; Grant & Lapp, 2011; International Reading Association, 2012; Pearson, Moje, & Greenleaf, 2010). Today's science teachers are charged with the work of preparing this citizenry by teaching students to make empowered, reasoned, and informed decisions through scientific literacy.

DISCIPLINARY LITERACY IN SCIENCE

Integrating literacy in science classrooms can be a challenging and controversial task. Many science educators seek to deemphasize the use of reading to avoid the text-centric practice of students reading about rather than doing science (Pearson, Moje, & Greenleaf, 2010). Research suggests that scientific literacy is a form of inquiry that enhances the active, hands-on process that is science, rather than substitutes for learning in science when done correctly (Gillis & MacDougall, 2007; Pearson, Moje, & Greenleaf, 2010; Tippett & Anthony, 2011). When teachers must cover a breadth of content to prepare students for high-stakes tests and when students find science texts to be disengaging and complex, it may seem more efficient for teachers to deliver science information to students. of Avoiding the challenge of mentoring students to engage actively in the process of making meaning of science will not foster citizens who think critically about science, though (Pearson, Moje, & Greenleaf, 2010; Grant & Lapp, 2011).

Though general literacy instruction is a respected practice, a "one-size-fits-all" approach to literacy-embedded classrooms fail to respect the ways students interact with materials in specific content areas (Lent, 2017). Researchers Houseal, Gillis, Helsing, and Hutchison (2016, p. 384) contextualize disciplinary literacy through the lens of the Next Generation Science Standards as "content determines process." The intersection of the three dimensions in the NGSS (disciplinary core ideas, crosscutting concepts, and scientific and engineering practices) and the connection of the dimensions to the scientific processes and unifying themes outlined in the Framework encompass disciplinary literacy in science (Houseal,

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Gillis, Helmsing, & Hutchison, 2016). The performance expectations identified in the NGSS are examples of outcomes in which students demonstrate scientific literacy (Houseal, Gillis, Helmsing, & Hutchison, 2016). The next section of this reading aims to provide some practical literacy tools and resources to promote scientific thinking, reading, writing, and speaking, such as those outlined by the performance expectations.

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SCIENTIFIC LITERACY TOOLS & RESOURCES

It is helpful for science teachers to first identify what content and behaviors students need, and then determine what instructional practices would be most useful to help students develop these scientific skills while also engaging students in the authentic work of what scientists do (Lent, 2017). Tippet and Anthony (2011) selected vocabulary/concept development, reading comprehension, visual literacy, science reading and writing genres, and oracy as the elements of scientific literacy in the framework they developed. Strategies for vocabulary and concept development in science include breaking down vocabulary words into their Greek and Latin roots to infer word meanings, annotating concepts maps and graphic organizers, and creating a word wall (Gillis & MacDougall, 2007; Lent, 2017; Pearson, Moje, & Greenleaf, 2010; Tippet & Anthony, 2011).

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While texts are the artifacts of science that document investigations and provide all current and future scientists with the background information necessary to reason about scientific phenomena, it can be difficult for students to construct meaning from these texts (Pearson, Moje, & Greenleaf, 2010). There are many close-reading strategies that can be used to help students comprehend texts such as scholarly journals, lab reports, essays, textbooks, trade books, news articles, investigation logs, and even science fiction readings. One such strategy is the THIEVES strategy in which students preview the Title, Headings, Introduction, Every first sentence, Visuals/Vocabulary, End of chapter questions, and Summary prior to reading (Tippet & Anthony, 2011). Students can also respond to a teacher-created anticipation guide with true/false statements before reading and then reconsider their responses to the statements after they read (Gillis & MacDougall, 2007). Inviting students to brainstorm questions they have before reading about a topic and then answer the questions they generated as they read is another way to engage with a text (Gillis & MacDougall, 2007). During reading, students can use the INSERT strategy (Gillis & MacDougall, 2007) to indicate with symbols whether information is known (✓), new (+), confusing (?), or something they disagree with (-). Read-and-think-alouds are also useful tools; students can be paired up for one to serve as the reader and the other to serve as the summarizer, or the teacher can read out loud, pausing to interject wonders about a statement, vocabulary word, or

graph/chart/table to model how scientists think (Gillis & MacDougall, 2007). It is also important to assign manageable chunks of reading material to students, perhaps through a Jigsaw strategy in which students split up the sections and then share what they learned (Gillis & MacDougall, 2007). The National Science Teachers Association and the American Association for the Advancement of Science both provide texts that science teachers can use as reading resources (Grant & Lapp, 2011).

Science also requires students to be visually literate in interacting with diagrams, models, graphs, tables, charts, images, and posters. Helping students make sense of data through modeled think-alouds is another strategy for comprehension in science. This process can also be more meaningful to students when they are given the opportunity to review real data from sources like the U.S. Environmental Protection Agency or the National Oceanic and Atmospheric Administration (Grant & Lapp, 2011). Knowing how to read and analyze data also contributes to students' oracy in science. Students must be able to construct arguments based on evidence, and Claim-Evidence-Reasoning is an excellent strategy for helping students develop this skill (Tippett & Anthony, 2011).

Other literacy tools shown to increase student understanding in science include K-W-L charts (or Observe-Infer-Conclude charts), foldables, Frayer models, semantic feature analyses, and Venn diagrams (Gillis; Grant; Houseal; Lent; Pearson; Tippett). The use of interactive notebooks has also been shown to promote students' scientific literacy (Pearson, Moje, & Greenleaf, 2010).

SUMMARY

Today's young people are faced with science-related decisions every day. When students are able to read, write, and think like scientists, they can comprehend and construct scientific information both as students and as citizens of the future (International Reading Association, 2012). Science educators play a key role in embedding literacy tools in their courses to help students achieve their potential, make informed and empowered decisions, and become an integral part of society's science discourse (Grant & Lapp, 2011).

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References:

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