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Instructional Scaffolding to Engage *All* Learners in Complex Science Text

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Abstract

Meeting the demands of the Next Generation Science Standards requires that students engage in complex science texts. However, for many students, including students with disabilities, this can be a challenging activity. Many students lack the necessary skills and background knowledge to successfully engage with complex science texts. In this article we discuss how to use instructional scaffolds to address gaps and challenges in reading as a way to engage all learners in complex science text.

National and state standards state that all learners should use informational texts (e.g., Next Generations Science Standards [NGSS]; CCSS-ELA-Reading in Science and Technical Subjects [RST]). Further, evidence supports the use of complex text in preparing students for college and careers (e.g., Council of Chief State School Officers, 2017). However, engaging our learners in grade level complex science texts can be an extremely difficult task and, as a result, avoided in our instruction (Fisher & Frey, 2014; Amendum Conradi, & Hiebert, 2018). Grade level complex science texts can present significant barriers for many learners, especially students with disabilities. For example, science texts often use technical and unfamiliar vocabulary, lack elaboration through examples, can be conceptually dense and contain abstract ideas, and involve unfamiliar text structures different from those seen in narrative or fiction text (Mason & Hedin, 2011).

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One approach to addressing barriers that grade level complex science text may present is via the use of a STEM multimodal text set -- a collection of resources from different genres, media, and levels of complexity (i.e., different reading levels) that are strategically organized to build vocabulary, background knowledge, and interest around a particular science topic (Folk et al., in press). There are many ways of organizing a multimodal text set. For our teacher professional development program, Linking Science and Literacy for All Learners, the line of inquiry of a text set is organized around an **anchor text**. Subsidiary texts, materials and resources, what we call **content scaffolds**, are organized around the line of inquiry and are designed to support the learner in developing the necessary content and skills and practices for engaging in the anchor text (see Figure 1 for overview).

Although a text set is scaffolded by arranging materials to ensure access to content for all learners, we know that simply providing materials leveled to a learner's reading ability is not necessarily enough of a scaffold. Some students, even though they can read (or decode) the text, may experience difficulty comprehending the text due to challenges such as lack of background knowledge or skills and practices, such as inferencing. Of further concern is that the exclusive use of a text at a lower grade level will lack sufficient complexity that, without exposure would result in, "...no opportunity to acquire the knowledge and skills that could enable them to catch up" (Shanahan, 2019, p. 22). Therefore, other **instructional scaffolds** may also be required. In our program, instructional scaffolds are specific learning opportunities designed to help meet the individual needs of learners (e.g., challenges with comprehension) so they can access and understand complex text. According to Fisher and Frey (2014), instructional scaffolding can be used as a way for readers to "grapple with text that is more difficult than they can access on their own" (p. 349). Therefore, the purpose of this article is to describe three forms of instructional scaffolds and provide examples, via Ms. Fielder's 8th-grade science class, of how these scaffolds are used to address some of the barriers students with disabilities might experience as they engage in complex science text.

Instructional Scaffolding Within a Multimodal Text Set: "Earth and Human Body Systems"

Ms. Fielder1 teaches 8th-grade science; most classes include some students with disabilities who experience difficulties reading complex text. Many of these students do not enjoy reading and lack the confidence to engage in reading complex science text. Ms. Fielder is planning on teaching a unit of instruction focused on human thermoregulation that includes ideas related to homeostasis and heat stress. She also plans on developing students' ability to make claims with evidence, a practice shared by NGSS and CCSS-RST (Lee et al., 2013).

To teach this unit of instruction, Ms. Fielder will be using a STEM multimodal text set titled "Earth and Human Body Systems." The anchor text for this text set was developed from a peer-reviewed published paper (Steinweg & Gutowski, 2015)2 that was adapted for middle

[1]Pseudonym

[2]Adapted from "Projected Changes in Greater St. Louis Summer Heat Stress in NARCCAP Simulations," by C. Steinweg and W. J. Gutowski, Jr., 2015, American Meteorological Society, 7, p. 159–168 (I159 DOI:10.1175/WCAS-D-14-00041.1). Adapted with permission.

school learners taking into consideration NGSS Standards, state Science and Language Arts Learning Standards (MLS), and CCSS-ELA.RST. (For a copy of the anchor text, see https://scienceandliteracy.missouri.edu website. Sample content scaffolds are provided in figure 2.) The Lexile text measure of the anchor text is 1060 (within the 6_{th}-8_{th} grade band [925–1185L]). (The Lexile text measure provides information as to how challenging a text is to read [see www.lexile.com]). A primary focus of the anchor text is the concern of increased temperatures leading to heat stress on the human body. Ms. Fielder recognizes that many of her learners would not be able to engage in the anchor text without additional instructional support in three specific ways: (1) development of background knowledge and vocabulary to understand the anchor text, (2) skill development to identify claims and evidence in the anchor text, and (3) knowledge of scientific text structures as a way to find information and, subsequently, build knowledge about the content in the anchor text.

Preview Instructional Scaffolding

To engage in the anchor text, the students need to understand and have vocabulary about thermoregulation and homeostasis. Knowing that some of her learners may not have the background knowledge or vocabulary, she uses *previewing* as an instructional scaffold prior to engaging in the anchor text. This type of scaffold can be particularly useful to build background knowledge and/or vocabulary (Fisher & Frey 2014). Texts, videos, simulations and other resources (such as those found within the content scaffolds of the multimodal text sets; see figure 2 for sample selection) can be used as preview scaffolds to build students' background knowledge and support students' vocabulary development.

Integrated as a part of a learning cycle with her class, Ms. Fielder created two learning opportunities designed as preview instructional scaffolds. First, to build background knowledge, she had her students watch a segment of the video *The Amazing Human Body* (PBS 2018). After watching the video, she facilitated a whole group student discussion regarding the main points of thermoregulation and its role in homeostasis. Second, to help develop a deeper understanding of the word 'homeostasis," she divided the class into small groups and assigned articles for them to read. After reading the articles, the students worked in small groups to complete a Frayer model graphic organizer on homeostasis (see figure 3). Ms. Fielder organized her groups to include mixed abilities in reading and writing.

Skill Development Instructional Scaffolding

Within the anchor text, claims related to change in weather patterns and heat stress are made that are supported by evidence in graphs. Ms. Fielder noticed that lack of familiarity with the practice of claim, evidence and reasoning (CER) was another challenge many of her learners experienced during science. To address this concern, Ms. Fielder used *skill development instructional scaffolding* prior to having students engage in the anchor text as a way to build understanding of CER. As its name suggests, skill development instructional scaffolding is focused instruction on building necessary skills.

Ms. Fielder decided to incorporate two learning opportunities designed as skill development instructional scaffolds into her learning cycles. For all her students, she introduced a "Bellringer"3 activity that they carried out during the first 10 minutes of class. This learning

opportunity often served as an “engage” activity for her learning cycle. For example, in her learning cycle on weather patterns and heat stress, the students were shown a photograph that provides a “scenario” open to interpretation that can serve as a tool to develop CER skills (see Figure 4). In this case, the photograph is of individuals trying to cool off in front of the Eiffel Tower in Paris during a heat wave in 2019. Individually and then via whole class discussion they were asked to answer the following questions:

1. What is going on in this picture? (Claim)
2. What makes you say this? (Evidence and Reasoning)

For the second skill development instructional scaffold, Ms. Fielder decided to implement learning in small groups. First, with the whole class, Ms. Fielder defined the terms *claim* (a statement that can be argued based on the study or reading), *evidence* (the information that provides the evidence for the claim), and *reasoning* (the logical explanation connecting the evidence to the claim). After illustrating and providing a model of claim, evidence, and reasoning statements, Ms. Fielder provided the students an article of video from the scaffolds of the multimodal text set that were focused on the topic of heat stroke/stress (see figure 2 for links to articles and videos). For their assigned resource, and in small groups, the students were asked to identify 3–5 claims along with evidence and reasoning related to the topic on key ideas such as (a) what is heatstroke; (b) causes of heatstroke; (c) signs of heatstroke; and (d) effects of heatstroke on the body. They then created a chart listing the claim along with evidence and reasoning. Once the students had completed the chart, they discussed what they found.

Ms. Fielder varied the activity by using one of the articles above and asked the students to read the article and then use highlighter pens in different colors to identify each component of the argument (i.e., green for claim and purple for evidence). Then, students compared their results in pairs and groups using the “think, pair and share” strategy to draw out their own conclusions.

Extension Scaffolded Instruction

The anchor text is adapted from the scientific literature, and as such has a variety of organizational structures (e.g., cause and effect) and text features (e.g., method, results, discussion) that vary from narrative or descriptive texts. Ms. Fielder was concerned that many of her learners would be unfamiliar with the text structure and face challenges in finding information and, subsequently, building meaning while reading. To help the learners engage with the anchor text, Ms. Fielder used an *extension instructional scaffold*. This type of scaffold can be used as a way to extend the students’ understanding of the content and support textual analysis of complex text, such as the anchor text, itself (Fisher & Frey 2014).

Ms. Fielder chose to include a learning opportunity within her learning cycle designed to develop student understanding of the text structure and features in the anchor text. After having her students partner read the anchor text (to ensure all could read the text), she

[3]This instructional scaffold was introduced to us by a colleague who was a part of our professional development program. Activity originally from: https://www.nytimes.com/2016/09/22/learning/40-intriguing-photos-to-make-students-think.html

developed a “scavenger hunt” game for the whole class designed to help her learners understand the text structure and features of the anchor text. Her questions included:

1. Where would you find the results?
2. How would you know how the study is carried out?
3. Where would you find definitions of words?
4. Where would you find evidence for a claim?

Strategically finding answers in the anchor text from questions can help scaffold students’ understanding of the structure of anchor text and, more broadly, information text such as research articles. Knowledge of text structures is important for aiding learners in constructing meaning of the text (Mason & Hedin, 2011).

Summary

Avoiding use of grade level complex science texts with our learners, particularly students with disabilities, can be detrimental to fulfilling the expectations of the Next Generations Science Standards (NGSS) and CCSS-ELA.RST. Research has demonstrated that limiting students with disabilities to text at their instructional level results in no gains (O’Connor, Swanson, & Geraghty, 2010). Rather, as Shanahan (2019) points out, restricting their access may “serve to isolate these children from their social peers. These students are so aware that they are being relegated to the ‘dumb books,’ with serious consequences for their self-esteem” (p. 22).

Carefully implemented, instructional scaffolds, such as the ones provided in this article, can give students an opportunity to grapple with more difficult text than they perhaps can access on their own (Fisher & Frey 2014). Not only can instructional scaffolds lead to stronger knowledge and understanding of the content, but development of skills to engage in complex science text and, importantly, improved confidence to do science.

References

Amendum SJ, Conradi K, & Hiebert E. (2018). Does text complexity matter in the elementary grades? A research synthesis of text difficulty and elementary students ‘ reading fluency and comprehension. Educational Psychology Review, 30(1), 121–151.

Council of Chief State School Officers, (2013) Navigating text complexity. National Governors Association, Washington D.C. www.ccsso.org/Navigating_Text_Complexity/Showroom_Models.html.

Council of Chief State School Officers, (2017) Supplemental Information for Appendix A of the Common Core State Standards for English Language Arts and Literacy: New Research on Text Complexity. National Governors Association, Washington D.C. https://eric.ed.gov/?id=ED576695

Fisher D, & Frey N. (2014). Scaffolded reading instruction of content-area texts. The Reading Teacher, 67(5), 347–351.

Folk W, Miller Z, van Garderen D, Lannin A, & Palmer T. (in press). “Flight of the Bumblebee”: Middle school STEM text set to support development of disciplinary literacy skills. Science Scope.

Lee O, Quinn H, & Valdés G. (2013). Science and language for English language learners in relation to Next Generation Science Standards and with implications for Common Core State Standards for English language arts and mathematics. Educational Researcher, 42(4), 223–233.

Mason LH, & Hedin LR (2011). Reading science text: Challenges for students with learning disabilities and considerations for teachers. Learning Disabilities Research & Practice, 26(4), 214–222.

O'Connor RE, Swanson HL, & Geraghty C. (2010). Improvement in reading rate under independent and difficult text levels: Influences on word and comprehension skills. Journal of Educational Psychology, 102(1), 1–19. 10.1037/a0017488

Shanahan T. (2019). Why children should be taught to read with more challenging texts. Perspectives on Language and Literacy, 17–19, 22–23. https://mydigitalpublication.com/publication/?m=13959&i=644729&p=16

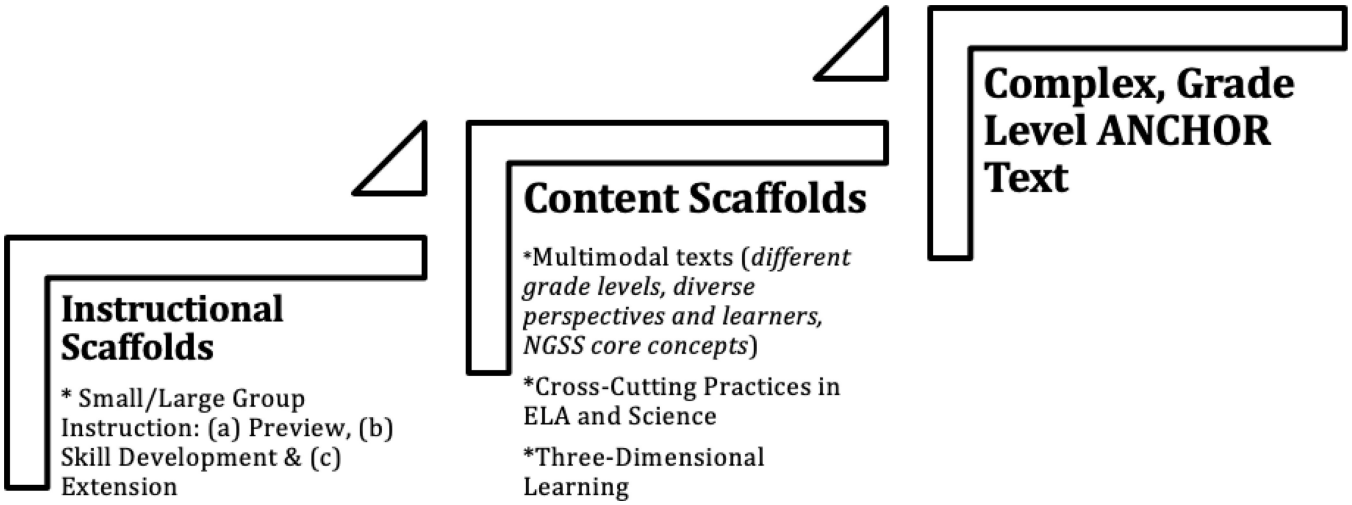

Figure 1.
Organization of a multimodal, STEM text set.

Title of Resource	Link to Resource	Grade Level	Comment
Thermoregulation Content Scaffolds			
Thermoregulation: definition and vocabulary	https://wiki.kidzsearch.com/wiki/Thermoregulation; https://kids.kiddle.co/Thermoregulation	**Grades 6-20**	**Wikipedia and Encyclopedia articles on thermoregulation.**
The Brain	https://askabiologist.asu.edu/bird-hypothalamus	**Grades 6-8**	**Science Text/scaffold of the brain in thermoregulation.** *Arizona State University*
The Amazing Human Body Video	**PBS-BBC DVD Segment 2 (Survival) first 14 min.**	**Grades 6-12**	**Excellent MP4 video/scaffold of human body systems adapting to thermal stress**
Heatstroke/stroke Content Scaffolds			
Surviving the Playing Field When it is Too Darn Hot	https://www.nytimes.com/2005/09/20/health/surviving-the-playing-field-when-its-too-darn-hot.html	**1100-1200Lxl**	**News Article about athletes and sickle cell disease:** *New York Times*
Heat, Energy, and Bicycling in New York City	https://www.readworks.org/article/Energy-and-Physical-Science/d55cb7f0-e838-46dc-b7b0-	**Grades 6-8**	**Science Text/scaffold that describes human body responses to heat stress:**

	3c12bf515f2c#!articleTab:content/contentSection:83bb706e-79e6-4173-973f-6fd6f0b62165/		*ReadWorks*
How Heat Kills	https://www.sciencenewsforstudents.org/article/explainer-how-heat-kills	**Grades 6-9**	**Science Text/scaffold with description of human body response to heat stress:** *Science News for Students*
What happens when you get heat stroke?	https://ed.ted.com/lessons/what-happens-when-you-get-heat-stroke-douglas-j-casa	**Grades 6-9**	**Video/Animation of the effects of heat stroke;** *TedEd*
States Take Aim at Heat Stroke	https://newsela.com/read/heatstroke-students/id/5513/	**Grades 4-9**	**Science text about efforts to reduce heat stroke in athletes;** *Newsela*
Vehicular Heat Stroke	https://www.youtube.com/watch?v=XNDWN8KDVSM&t=325s		**Safety film about dangers of vehicular heat stroke.**
Mercury Rising	https://www.youtube.com/watch?v=u4Y3OEDdpJA	Grades 7-12	**Series 1 Segment 8 of** *Years of Living Dangerously* **video with Matt Damon talking about heat stress in LA (10 min)**

Figure 2.
Sample Content Scaffolds for Multimodal Text Set

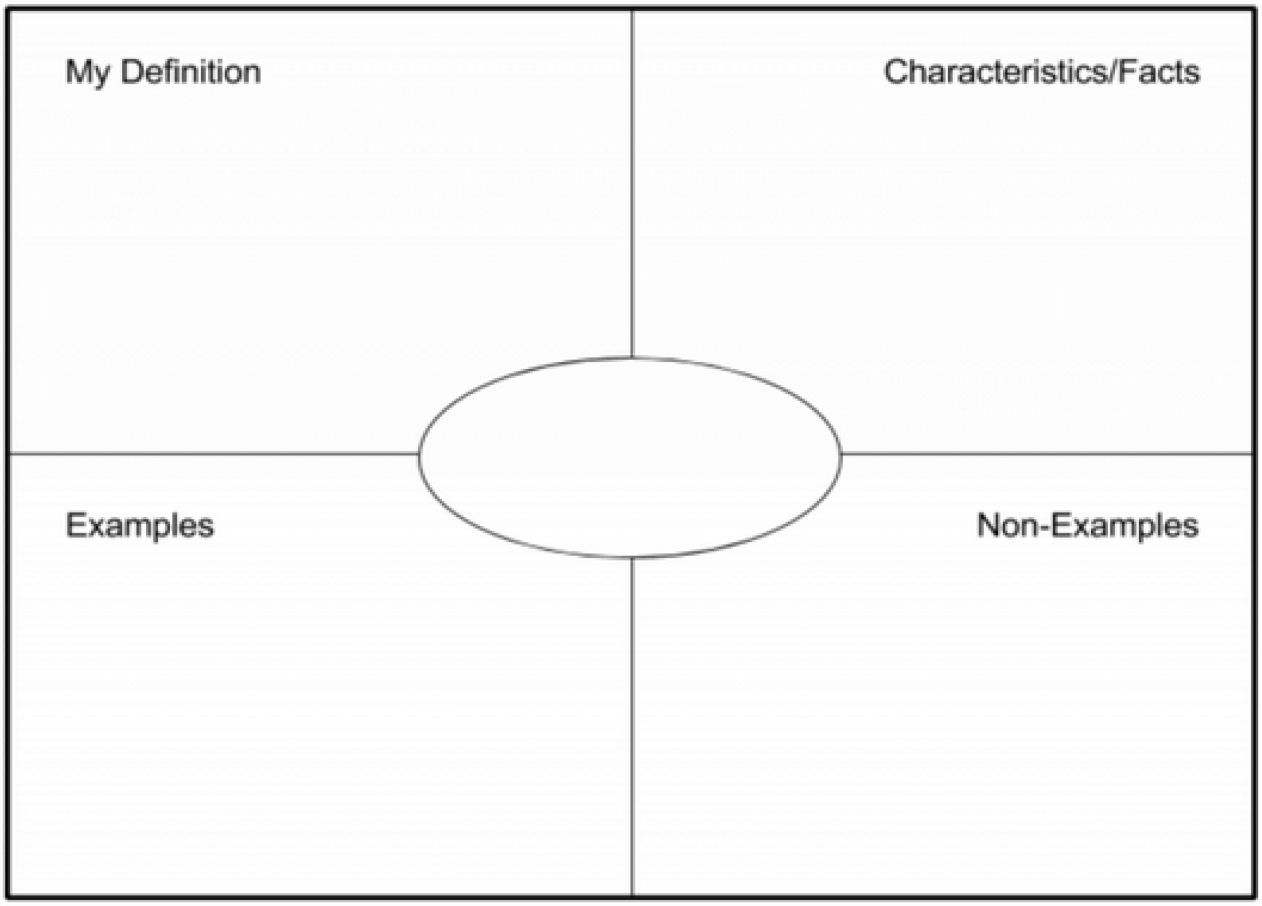

Figure 3.
Frayer Model example template.

Figure 4.
https://phys.org/news/2019–08-scientists-july-global.html