Reading Strategy Guides to Assist Middle School Educators of Students with Dyslexia

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Abstract. According to the 2010 International Dyslexia Association publication, “Knowledge and Practice Standards for Teachers of Reading,” effective instruction is the key to addressing students’ reading difficulties associated with dyslexia, a language-based disorder of learning to read and write. “Informed and effective classroom instruction….can prevent or at least effectively address and limit the severity of reading and writing problems.” The Interstellar Boundary Explorer (IBEX) mission Education and Public Outreach program recently funded the development of six strategy guides for teachers of middle school students with reading difficulties, especially dyslexia. These guides utilize space science-themed reading materials developed by the Great Exploration in Math and Science (GEMS), including the IBEX-funded GEMS Space Science Sequence (Grades 6–8). The aforementioned reading strategy guides are now available on the IBEX mission website.

1. What is Dyslexia?

According to the International Dyslexia Association (IDA 2008, 2010), dyslexia is a neurologically-based, specific learning disability that severely impedes the processing of spoken and written language. Although there is some disagreement regarding the prevalence of dyslexia, some scholars estimate as many as 15–20% of the population at large exhibit characteristics of reading difficulty while others contest that only 2% of people with reading difficulty actually exhibit the biological differences that characterize dyslexia (IDA 2008; Pressley 2002; Shaywitz & Shaywitz 2004).

Any estimate of the pervasiveness of dyslexia relies on many factors, but a recent review by Gabrieli (2009) estimates that 5–17% of children suffer persistent reading difficulties associated with dyslexia. Regardless of how many people suffer from the debilitating obstacles of dyslexia, educational research continuously seeks to understand how to best ameliorate the learning difficulties of these individuals.

Those who identify as dyslexic attest to the real and significant challenges they face in all aspects of reading and many other aspects of learning (Kamhi & Catts 1999; Pressley 2002). Advances in neurobiological studies of dyslexia reveal anatomical and physiological differences in the brains of individuals with dyslexia (Gabrieli 2009; Wolf 2007). In general, the hallmark characteristics of developmental dyslexia include atypically developed neural pathways that link parts of the visual system of the brain to the language processing centers of the brain, which impedes fluent decoding and efficient
comprehension of written text (Butler & Silliman 2002; Kamhi & Catts 1999; Pressley 2002; Savage 2004; Shaywitz & Shaywitz 2004). However, accurate and efficient word recognition is just one of the many factors that may impede dyslexic readers; productive language skills such as spelling and writing also pose problems for individuals with dyslexia, as do tasks that involve information processing and working memory (Bakker 2004; Savage 2004).

Dyslexia is considered to be between 50–75% heritable, yet environmental factors also play critical roles in the severity of expressed dyslexic traits (Gabrieli 2009) or the degree to which individuals compensate for these traits. In addition, many individuals with dyslexia develop incredible talents and enjoy successful life circumstances despite a lifelong diagnosis of dyslexia (Fink 1996, 1998; Schneps, Rose, & Fischer 2007; Wolf 2007). In fact, Matthew Schneps, Director of the Laboratory for Visual Learning at the Harvard-Smithsonian Center for Astrophysics, suggests that individuals with dyslexia may have relative strengths in the peripheral visual field that make them highly compatible for work in domains such as space science (Paul 2012; Schneps et al. 2007).1

2. What Constitutes Effective Instruction for Students with Dyslexia?

Students with dyslexia experience many challenges with reading informational text. To mediate these difficulties, Lemke (2004) suggests that teachers mediate engagement with scientific texts by explicitly attending to text characteristics and uses. However, many science teachers are not necessarily well prepared to teach science text comprehension (CAAL 2010; Snow 2010), or perceive doing so as a laborious chore, rather than an active process of constructing meaning (Tovani 2004) or an act of inquiry (Pearson, Moje, & Greenleaf 2010). In addition, most instructional approaches to text comprehension are simply too generic to adequately address the disciplinary literacy demands in science or the special educational needs of students with dyslexia (Lee & Spratley 2010; Moje 2007; Shanahan & Shanahan 2008). Students with dyslexia, in particular, benefit from “explicit, systematic, cumulative, and multisensory” instruction.

The six currently available literacy strategy guides described below integrate reading, writing, listening and speaking to support understanding of complex science concepts such as the size and scale of the universe, the processes of star life cycles, orbital patterns of movement and seasons on planets other than Earth. Furthermore, these strategy guides emphasize planning, organization, attention to task, critical thinking, and self-management. While all such aspects of teaching are essential for students with dyslexia, these strategies also enhance the potential of all students.

3. Strategy Guides

The IBEX Education and Public Outreach program funded the development of seven strategy guides for middle school teachers. The first six guides utilize student text from Great Explorations in Math and Science (GEMS) Space Science Sequence for Grades 6–8: Teaching How Scientists Use Models with What Makes Up Most of the Solar System?, Teaching Roundtable Discussions with Seasons on Mars, Teaching Text Structure

1For more information, see http://www.cfa.harvard.edu/dyslexia/LVL/
with *Understanding the Scale of the Universe*, Teaching Vocabulary Awareness with *Observing Stars*, Teaching Science Vocabulary with *The Shape of the Moon’s Orbit*, and Teaching Scientific Comparison Writing with *Pluto and Charon*.

An additional strategy guide detailing accommodations for middle school students with dyslexia that was designed to accompany the GEMS Space Science Sequence for Grades 6–8 will be available in Fall 2013. The development of the GEMS Space Science Sequence for Grades 6–8 was partially funded by the IBEX Education and Public Outreach program and led by the Lawrence Hall of Science. The GEMS Space Science Sequence is designed to address age-appropriate core concepts in space science and common misconceptions that students have about them, and it is divided into four units: *How Does the Sun Affect the Earth?*, *Why Are There Seasons?*, *The Solar System*, and *Beyond the Solar System*. Within each of the units, students explore different areas of space science, building on what they have learned, having their misconceptions challenged, and making connections to other areas of science they have studied.

### 3.1. Development of GEMS Literacy Strategy Guides

Two teachers, Tanya and Monique (pseudonyms), were recruited from an existing network of mentor teachers involved in a National Aeronautics and Space Administration Education/Public Outreach (NASA EPO) project designed to advance novice teachers’ instruction in space science. Although these participants were considered accomplished teachers of space science, both teachers reported wanting to learn more about literacy practices in science.

Upon agreeing to participate in the project, each teacher received 12 short reading passages about space science topics and completed a questionnaire before administering them to all of the students in their science classes. Students were asked about their attitudes toward reading and science and the strategies they use when reading. Student then read the text and completed a brief exit-questionnaire about their reactions to the text.

After analyzing teacher and student responses, six of the twelve texts were paired with strategies to address the challenges identified. Each teacher then taught three of the strategies and provided a narrative description of their lesson, including students’ reactions to the strategies. Overwhelmingly, teachers reported students responded positively to the instruction.

### 3.2. Description of Literacy Strategy Guides

The literacy strategy guides described herein combine several elements considered by experts to foster reading comprehension (Duke et al. 2011), including tasks that provide contextual support that builds on firsthand inquiry, material support that includes accessible and reader-friendly text, and individual reader support that couples explicit modeling with scaffolded opportunities for practice. With these aspects of instruction in mind, supporting students’ comprehension of space science text begins with purposeful attempts to activate and build background knowledge about one of the most intriguing topics in science.

#### 3.2.1. Contextual Support: Building on Firsthand Science Inquiry

Inquiry-based science instruction provides an ideal instructional context for encountering complex informational text. Space science is a particularly intriguing area of
science, one that motivates and interests many learners. As former astronaut George D. Nelson (2009) explains, astronomy not only builds students’ understanding of our place in the Universe, it inspires creativity and excites potential.

One way to spur students’ thinking about text is to engage them in peer-to-peer discussion about a guiding question that sets purpose for reading. Because effective inquiry-based instruction relies on firsthand experience, multimedia resources using strategic points can augment information that students garner from printed text. Finally, applying new ideas solidifies student understanding of informational science text, so this framework prompts students to discuss or write about topics they encounter in the text.

3.2.2. Material Support: Accessible Student Text

The informational space science texts selected for use were designed to fulfill a range of reading purposes that appeal to a middle school reader. Texts written to convey historical trends differ from those that prompt students to understand a complex process. For instance, the article Understanding the Scale of the Universe describes key historical milestones in the development of scientists’ expanding ideas of the vastness of space. To best convey these ideas, the article employs key words that signal a time-order text structure. Another text, Pluto and Charon, uses a comparison text structure to describe how two solar bodies orbit one another, which makes an abstract concept more easily understood.

Apart from distinct text structures, these short one to two-page informative articles use reader-friendly language, rhetorical devices, and embedded vocabulary explanations to support reading comprehension. Furthermore, the space science texts in this series also include familiar analogues, concrete examples, and visual representations to further explicate abstract concepts. Finally, headings, paragraph structure, and text features (such as captions) serve to signal main ideas and connect portions of text in ways that guide the readers’ attention.

3.2.3. Individual Support: Accommodations for Students with Dyslexia

Individual reader characteristics influence the act of comprehending, even when readers are unaware of their cognitive processes (Duke & Carlisle 2000). For instance, readers might call to mind a related personal experience while reading, yet they may not recognize the process of recollecting as “making a connection” to the text (common parlance in comprehension strategy instruction). Yet, even when explicitly instructed, middle school readers may struggle with various aspects of expository text comprehension because of limited knowledge of how texts operate in science, limited knowledge of the world, or limited interest and motivation.

To further intensify these variables, students with dyslexia have additional challenges due to limitations in oral language, short-term memory capacity, and processing efficiency (Gersten, Fuchs, Williams, & Baker 2001). Despite these challenges, interventions that focus on content knowledge or cognitive strategies have shown promising results for students with disabilities (Gajria, Jitendra, Sood, & Sacks 2007). Drawing from research in successful interventions found to increase comprehension of expository text for students with learning disabilities in reading, the comprehension instruction detailed here includes several suggested accommodations for students with dyslexia. The number and type of accommodation depends on the conceptual topic of
the text, the characteristics of the text, and the task that students are asked to complete using the text, but generally include at least three of the following:

1. Modify reading materials.
2. Provide explicit instruction.
4. Enhance information processing.
5. Provide more experience.
7. Allow for independent investigation.

3.3. Development of the Forthcoming Accommodations Strategy Guide

This final portion of the project is designed to create reading support materials for the GEMS Space Science Sequence curriculum, but is also designed to be a general reading strategy reference guide for middle school teachers who do not actively use the GEMS Space Science Sequence. First, the IBEX EPO team surveyed teachers of middle school students with dyslexia to identify the types of materials those teachers use now or materials that they could use to help their students with dyslexia succeed in science class. Next, a sub-group of six highly-qualified middle school teachers of students with dyslexia traveled to the Adler Planetarium in Chicago, Illinois in July 2012 to participate in a three-day extended focus group session. The goal of the session was for the participating teachers to learn many of the GEMS Space Science Sequence curriculum lessons and then work with a session facilitator to identify strategies and materials that students with dyslexia would need to get the most out of the curriculum, especially those components involving reading and writing exercises. IBEX EPO staff then used these suggestions to create the accommodations strategy guide text.

3.4. Accommodations Strategy Guide

This forthcoming strategy guide contains accommodation suggestions for reading, organization, and vocabulary, as well as additional explanatory text, and every accommodation is mapped to all relevant lessons in all four GEMS Space Science Sequence for Grades 6–8 units.

4. Availability

The reading strategy guides are available on the IBEX mission website. At the time of the submission of this paper, the seventh strategy guide had just passed the NASA Education Product Review process. The guide will also be available online and is expected to be available during Fall 2013.

\(^2\)http://www.ibex.swri.edu/educators/formal.shtml
5. Conclusion

Many readers face extreme challenges when asked to comprehend informational science text and many science teachers are flummoxed about how to instruct them. These barriers are even more salient for teachers of students with dyslexia. However, researchers have not yet addressed literacy development in science for students with dyslexia. The goal of this set of strategy guides is to address the literacy demands in space science so students with dyslexia have access to the same knowledge and practices as their peers. Because reading in science is considered an act of inquiry, the instructional suggestions in this series offer ways to purposefully engage students in collaborative meaning-making when they encounter complex text. In accordance with effective inquiry-based science instruction, the comprehension framework that guides these six strategy guides blends content knowledge with authentic practices of science to engage students in space science literacy.

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