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Authors

Arya, Diana J
Maul, Andrew

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Why Sociocultural Context Matters in the Science of Reading and the Reading of Science: Revisiting the Science Discovery Narrative

Diana J. Arya

Andrew Maul

University of California, Santa Barbara, USA

ABSTRACT

Our purpose in this study was to more deeply understand the ways in which text-based, sociohistorically situated narratives can be optimally used for promoting reading comprehension. In particular, we sought to understand the experiences and perspectives of young readers from diverse backgrounds (N = 24) as they engaged with science discovery narratives (i.e., stories by or about scientists engaged in the process of discovery), which have been shown to have advantages over traditional expository texts (i.e., those that present information without attending to the discovery process) in fostering comprehension of targeted conceptual information. Interviews were conducted and analyzed using a sociocognitive framework that positioned participants as reviewers of text quality. Findings suggest that the personal and sociohistorical elements of science discovery narratives were effective in engaging readers' interest and helped highlight the culturally situated nature of knowledge and the nature and processes of scientific inquiry. We conclude by arguing that in the development and instructional use of texts, educators would do well to consider the ways in which foregrounding sociohistorical considerations can foster engagement and, hence, greater comprehension in readers from diverse backgrounds.

Reading has never been as complex and challenging as it is now in the 21st century, both in terms of what kinds of textual sources we engage with and how we engage with them. Reading practices are both shaped by and help shape increasingly diverse sociocultural contexts of our schools. Against this backdrop, the research community associated with the science of reading (SOR) is faced with the challenge of considering how practices and resources associated with reading in schools can best serve student populations living and learning within such increasingly diverse contexts, as illustrated by the fall 2020 special issue of *Reading Research Quarterly*. The authors featured in this issue highlighted a range of viewpoints, collectively helping to push the field past primitive and divisive thinking regarding best practices for reading instruction (e.g., phonics vs. whole language) and toward broader recognition of the need for explicit and careful consideration of the sociocultural context in scientific studies of reading (e.g., Alexander, 2020).

Textual materials related to scientific exploration and innovation are of key importance for literacy educators and reading researchers, as evidenced by the new *Reading Assessment Framework for the 2025 National Assessment of Educational Progress*, which emphasizes science in particular as a key context for engagement in disciplinary practices of reading, including "considering sources and chronologies of

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ideas, comparing claims about causality, and interpreting rhetorical devices…as they critically reason about ideas in real-world and discipline-specific texts" (National Assessment Governing Board, 2020, p. 25). However, despite being one of the most venerable components of education, text-based resources used in schools remain deeply problematic. Particularly within the realm of science education, systematic evaluations of the most widely used school textbooks have suggested a long streak of failures in meeting quality standards of educators and scientists alike (American Association for the Advancement of Science, 2002; Apple & Christian-Smith, 1991/2017; Niaz & Rodríguez, 2000; Pellegrino, Peters-Burton, & Gallagher, 2018; Román, & Busch, 2016; Staver & Bay, 1987; Vojíř & Rusek, 2019).

Increasingly, these failures are recognized not only as an issue of texts' suboptimal utility for narrowly defined educational purposes (e.g., the traditional targets of standardized tests) but also as having broader consequences for equity and social justice. As discussed by Apple and Christian-Smith (1991/2017), texts may enforce "social control insofar as they legitimate the status of dominant groups" (p. 90) by framing science as monolithic, ahistorical, and the privileged province of the elite few (see also Binns & Bell, 2015). Such texts are increasingly recognized as not only ideologically regressive and counterproductive to the goal of making STEM education and career pathways more accessible to students from diverse backgrounds but also empirically indefensible, insofar as making texts more socioculturally inclusive has been shown to directly contribute to reading comprehension development (e.g., Good, Woodzicka, & Wingfield, 2010; Lesaux, 2006), and also insofar as cultural and intellectual diversity is increasingly recognized as an asset to the scientific community (e.g., "Science Benefits From Diversity," 2018).

Thus, sociohistorical inclusiveness is, or at least should be, a core element of the subject matter of scientific studies of reading. Reading comprehension has been long understood as an interaction among the reader, the text, and the activity or task at hand (e.g., responding to questions about a text for a particular purpose), all of which takes place in a sociocultural context (e.g., Cervetti et al., 2020; Pearson, 2009; Sweet & Snow, 2003). A principal challenge for the SOR subfield, then, is to clarify the conditions under which readers can be optimally supported in their comprehension of texts, which inevitably requires consideration of the ways in which sociohistorical forces differently affect matters within texts, readers, and the interaction between the two. To wit, SOR work has increasingly acknowledged the power that texts have in positioning readers in "normative (often gendered, racialized, classed, and colonized) ways of knowing, being, and doing" (Phillips Galloway, McClain, & Uccelli, 2020, p. S332). Further, several authors from the aforementioned special issue recognized the dominance of quantitative studies in SOR research and the need for qualitative approaches that would contribute to key issues and constructs that cannot be easily quantified (Milner, 2020; Noguerón-Liu, 2020; Phillips Galloway et al., 2020).

In this study, we took up both of these challenges by qualitatively examining the experiences of a diverse group of readers (N = 24) interacting with a particular genre of text designed to enhance one's understanding about the sociohistorical contexts of scientific discoveries called the science discovery narrative (SDN), which has been shown to boost reading comprehension relative to traditional school texts, particularly for students from historically marginalized backgrounds (Arya & Maul, 2012). SDN texts were designed to foreground the cultural backgrounds, motivations, and challenges of scientists living in different sociohistorical conditions. Specifically, with this research, we aimed to address the following research question: How do middle school readers from diverse backgrounds perceive and evaluate their experience of engaging with SDNs as compared with non-SDN texts matched in terms of concept-specific information?

In our study, which we hope may serve as an example of how sociocultural considerations can be foregrounded in scientific inquiry about reading, we used discourse analysis as a way of exploring expressed ideologies (van Dijk, 1995/2005) in interviews with 24 middle school students after reading two of four experimental texts, one of which is a SDN and the other a more traditional expository text that covers the same scientific content (sans sociohistorical context). Student participants were asked about the inclusion of the SDN for one of the topics presented and what difference this additional content made in terms of their reading experience. The students were positioned as reviewers of the experimental texts and were invited to share opinions regarding the content and accessibility of each text.

Previous Work on Science Texts

Our study builds on previous work about text-based resources, particularly science texts, as well as a smaller body of work on the use of narratives in comprehending informational texts. This study also builds on previous work aimed at understanding issues of sociohistorical context, representation, and diversity, particularly within science texts.

A substantial amount of empirical work has examined the roles that texts can play in learning about science and, in particular, has highlighted the value of texts designed for particular inquiry-based purposes (e.g., field journals) for building understanding of what it means to engage in scientific thinking and for developing reading comprehension skills and abilities (e.g., Cervetti, Barber, Dorph, Pearson, &

Goldschmidt, 2012; Hapgood, Magnusson, & Palincsar, 2004; Hynd & Alvermann, 1986). A smaller number of studies have investigated the potential benefits of scientific narratives for fostering reading comprehension (Arya & Maul, 2012, 2016; Fulford, 2016; Lin-Siegler, Ahn, Chen, Fang, & Luna-Lucero, 2016). Such studies have largely focused on what might be termed *proof of concept*; for example, an experimental investigation of SDN and non-SDN texts on two topics in middle school science classrooms found that students demonstrated greater comprehension ability when reading the SDN versions in terms of both immediate and longer term recall of concept-specific information (Arya & Maul, 2012). Similarly, Lin-Siegler and colleagues (2016) found in their study of 402 high school students that motivation to learn about science increased after reading narratives featuring scientific struggle both personally and professionally. Fulford (2016) found that undergraduates who read science-related historical narratives demonstrated greater comprehension as compared with students who read more traditional expository texts that covered the same conceptual content; Klassen (2007) summarized studies reporting similar positive outcomes, describing how students enjoyed learning about electromagnetic applications through the historical account of Lord Kelvin and the development of Atlantic cable communications. These findings collectively highlight the importance of the sociohistorical and sociocultural context that is invariably present in such narrative texts for fostering reading comprehension ability.

Narratives can be understood as social tools for navigating various lifeworld contexts, including formal education. The universal familiarity of the narrative structure has been noted as a warrant for using stories for communicating and supporting the comprehension of scientific content in texts (e.g., Avraamidou & Osborne, 2009; Murmann & Avraamidou, 2014; Prins, Avraamidou, & Goedhart, 2017), and some empirical work has found that students demonstrate greater conceptual understanding and textual comprehension when information is encased in a narrative structure, such as a scientist's journal (Palincsar & Magnusson, 2001) or a pictorial narrative about human evolution (Browning & Hohenstein, 2015). Psychologists have long cited the power of narrative for recalling information more effectively (e.g., Baddeley, 1994), although some educational scholars have noted the perils of seductive details, which can be difficult to avoid and may sometimes be more engaging than the targeted factual information (Groot Kormelink & Costera Meijer, 2015; Jetton, 1994; Madrazo, 1997; Mayer, 1995; Rice, 2002; Whitebrook, 2001/2014).

Scholarly work on the use of narratives in education has also intersected with equity-focused work attending to issues of inclusion and representation, such as the digital youth program researched by Pinkard, Erete, Martin, and McKinney de Royston (2017), who used narratives to engage and inspire adolescent girls learning about computer science. Such work is urgent given the well-documented underrepresentation of women and scientists of Color in science books aimed at young people (e.g., Ford, 2006; Kelly, 2018; Rawson & McCool, 2014) and is particularly poignant given findings that inclusive representation may mitigate the effects of stereotype threat, which has been shown to impact one's ability to comprehend science texts (Good et al., 2010).

There is increasingly broad recognition in both the literacy and science education communities that science itself is a sociohistorically dynamic and situated process of creative exploration, experimentation, and discovery, in contrast to earlier "final form science" frameworks that framed scientific knowledge as decontextualized, ahistorical, and value-neutral factual content (for a discussion, see, e.g., Duschl, 2008). As has been well documented by sociologists of science, such as Gilbert and Mulkay (1984) and Woolgar (1981), traditional forms of scientific communication focus on the context of justification rather than the context of discovery and can thus give a distorted view of the scientific process through their emphasis on brevity and replicability, bracketing out the sociocultural and historical factors that shape how knowledge comes into being. Genuine scientific literacy requires more than understanding of what has traditionally been called science content; rather, students greatly benefit from engaging with the messy, iterative, nonlinear, and sociohistorically shaped experiences of scientists themselves (see, e.g., Bowker, 2005; Glynn & Muth, 1994; Leite, 2002; Lemke, 1990; Niaz & Rodríguez, 2000; Norris & Phillips, 2003; Norris, Phillips, & Korpan, 2003; Unsworth, 1997). Here, too, science textbooks and trade books written for young people have been woefully lacking, as they typically fail to foreground the diversity of the actual, varied, and situated processes through which scientists investigate the natural world (see, e.g., American Association for the Advancement of Science, 2002; Bowker, 2005; Brunner & Abd-El-Khalick, 2017; Dagher & Ford, 2005; Niaz & Rodríguez, 2000; Siegel, 1978; Welsh, 1979). Again, given that all acts of reading comprehension are necessarily of some content and for some purpose, such sociohistorical matters are inseparable from the goals of fostering reading comprehension skills and abilities and hence a key issue for SOR research.

Thus, there seems to still be much work to be done both to better understand the optimal use of narratives in educational contexts for supporting reading comprehension development and to better understand how sociocultural and sociohistorical considerations can be better integrated into textual resources for developing readers. In the next section, we describe a genre of scientific text developed specifically to address these challenges.

The SDN

The SDN is a particular genre of scientific communication which traces how one or more scientists came to understand something new about the world. Such accounts often come from the scientists themselves and, unlike most genres of formal scientific writing, foreground descriptions of the situated, personal processes by which knowledge was constructed. Such narratives thus foreground the nonlinear aspects of inquiry and discovery, including accounts of serendipitous or idiosyncratic events and mishaps or setbacks deemed relevant by the authoring scientist(s). The design of SDNs for our original study was based on a systematic exploration of 12 primary textual sources written by scientists, including the inventor and chemist Jabir (1942), biochemist and inventor George Washington Carver (1987), and anthropologist Jane Goodall (1971), representing a diverse range of disciplines, sociohistorical conditions, genders, and ethnic identities (Arya, 2010; Arya & Maul, 2012). Criteria for selection were that the text be in print form, be available in English, and include explicit mention by the authoring scientist(s) that their purpose was, at least in part, to inform readers about the process by which they came to a particular discovery. All such texts included discussion of the motivations and struggles of the authors, as well as the surrounding circumstances of the times.

These SDNs foreground the subjective perspectives of the authoring scientists, including both positive and negative emotions, such as curiosity, excitement, and wonderment; ambition and jealousy; confusion, frustration, and doubt; and sometimes despair. These SDNs also include references to cultural or political factors that affected scientific work, such as Goodall's (1971) account of struggles with the government of Tanzania, who did not believe that single women should engage in chimpanzee studies. It was hoped that the SDNs would invite the reader to vicariously experience the events through the perspective and prerogative of the scientist(s) involved. The differences between SDNs and more traditional forms of scientific communication are illustrated by the excerpts from Nobel Prize–winning microbiologists Marshall and Warren (Marshall, 2002; Marshall & Warren, 1984) shown in Figure 1.

Both of the excerpts describe the study in which the growth of the *H. pylori* bacteria was observed. The excerpt on the left comes from a chapter written by Marshall in the book *Heliobacter Pioneers: Firsthand Accounts From the Scientists Who Discovered Heliobacters*, which, as indicated by its title, describes the events that led to the discovery that ulcers are a result of a bacterial infection and can be treated with antibiotics. The excerpt on the right comes from the original scientific publication in which Marshall and his colleague Warren reported their initial findings on *H. pylori*. The highlighted portions in both excerpts are similar; however, the surrounding context for each description is clearly quite different. Within the SDN featured in his book, Marshall gave a rich account of the events that led to the first observations of the elusive bacteria *H. pylori*, including a description of how an oversight on the part of a technician led to accidental overincubation of a sample of bacteria, which then proved serendipitous in that it called attention to an unexpected pattern of bacterial growth. By contrast, in the original published study, Marshall and Warren focused on issues important for reproducibility of their final results, such as the optimal conditions (e.g., temperature, medium) for culturing the bacteria, without an account of the trial-and-error process through which they earned this knowledge.

Texts that reflect the genre style and organization of published scientific reporting are arguably helpful for illuminating prevalent literacy practices of scientific communities. However, it seems just as clear that the very features of such textual sources that make them well suited for their intended purposes can limit their utility when used for other purposes in education, particularly for the purposes of illuminating the processes and practices of scientific communities and the ways in which members of such communities write about their experiences. SDNs such as Marshall's (or age-appropriate adaptations thereof) would be of particular value for developing readers for at least three reasons. First, when used optimally, SDNs may outperform traditional expository texts in assisting young readers in comprehending academic texts. Second, SDNs may also be helpful to readers in building an understanding of the textual and organizational elements unique to a particular genre of scientific writing. Third, and perhaps most critical, SDNs engage readers in thinking about the contextual, human elements of academic subjects such as science, at both intimately personal and broader historical-societal levels, which can in turn invite readers to personally associate with these narratives. We aimed to explore these possible explanations from the perspective of readers who had minimal direct input about the affordances of narrative texts like the SDN.

Method

Participants and Texts

Twenty-four middle school students in an urban environment read two adapted texts related to two topics, radioactivity (entitled "Radioactive Substances") and the use of telescopes to observe planetary rotation in space (entitled "Seeing at a Distance"), and were interviewed regarding their experiences in reading these texts. Each text was adapted in both SDN and traditional expository (i.e., non-SDN) formats and, apart from the difference in narrative structure, were matched as closely as possible in

FIGURE 1
Comparative Excerpts of Two Accounts of a Study

From, Marshall, B. (2002). The discovery that Heliobacter pylori, a spiral bacterium, caused pepetic ulcer disease. In B. Marshall (Ed.), *Heliobacter pioneers: Firsthand accounts from the scientists who discovered heliobacters, 1892-1982.* Chapter 15 (165-201).

Unbeknown to us, junior microbiology staff in the 'feces lab' where our biopsies had been relegated, were treating them much as they did feces cultures or throat swabs. Thus, expecting to see complete overgrowth of the agar plate after 48 hours, the plates were routinely examined at 48 hours and, if no unusual organisms were present, they were discarded. However, because of the workload over Easter 1982, an oversight occurred and the busy weekend microbiology technician did not examine the research plates on Saturday morning. Thus, the plates remained in the incubator until the next working day, Tuesday 13 April. On that day, the small transparent colonies of *H. pylori* were evident. The organisms were subcultured, and it was not until the following weeks that John Pearman telephoned me in an excited voice to say that the new Bacteria had been cultured. I recall he showed me some unimpressive blood agar plates and a Gram stain in which the organism certainly did not resemble the curved and spiral forms present in the histology. By then, however, they had already cultured the bacterium from another patient and were moderately confident that it was the CLO we were seeking. (p. 177).

From, Marshall, B.J. and Warren, J.R. (1984). Unidentified curved bacilli in the stomach of patients with gastritis and peptic ulceration. *The lancet*, June 16 1984, 1311-1315.

The bacteria were S-shaped or curved gram-negative rods, 3µm x 0.5 µm, with up to 1½ wavelengths. In electron micrographs that had smooth coats and there were usually four sheathed flagella arising from one end of the cell. They grew best in a microaerophilic atmosphere at 37° C; a campylobacter gas generating kit was sufficient (Oxoid BR56). Moist chocolate or blood agar was the preferred medium. Growth was evident in 3 days as 1 mm diameter non-pigmented colonies. In artificial media the bacteria were usually larger and less curved than those seen on Gram stains of fresh tissue. They formed cocoid bodies in old cultures. The bacteria were oxidase +, catalase +, H_2S +, indole -, urease -, nitrate -, and did not ferment glucose (p. 1313).

terms of conceptual content and other features (for further details on the development and vetting of the texts, see Arya, 2010).

Fifteen students from the sample of interviewees attended an urban middle school in the Pacific Northwest of the United States. The other nine students attended an urban middle school in the California Bay Area. The selection of students for interviewing could be considered a stratified random sample, insofar as names of students were randomly pulled from a total list of students, resulting in the number of participants for each of the identified groups presented in Table 1.

The two SDNs were crafted based on original work written by Marie Curie (1904) and Galileo Galilei (1989), respectively, with a focus on content and textual accessibility that aligned with grade-appropriate expectations. As described in the original study, the SDNs were slightly longer, due solely to the added narrative context for the conceptual information; apart from this, the non-SDN texts mirrored the SDN texts in terms of conceptual density, voice (using conversational, personal pronouns), pictures, and format (small booklets), as confirmed by the expert review panel. Figure 2 features a juxtaposition of excerpted portions from each of the two SDNs. The two SDNs used in this study display diversity in gender (of the respective protagonists), scientific discipline, and sociocultural contexts and their attendant challenges. For example, although both of these scientific giants were pursuing a particular mystery, they operated within distinct sociocultural contexts: Gallilei had to contend with the Catholic Church and its rejection of heliocentrism, whereas Curie had to contend with early 20th-century views of women becoming scientists.

TABLE 1
Descriptive Profile of Participating Readers

	Pacific Northwest school	California Bay Area school	Average ranking of science-related reading topics of interest (by group)
Total number of readers (*N* = 24)	15	9	
Expressed preference for science discovery narratives	10	8	
Grade			
6	5	3	Jupiter (#9)
7	5	3	Jupiter (#7), radioactivity (#10)
8	5	3	Radioactivity (#8), Jupiter (#10)
Reported gender			
Female	7	5	Jupiter (#6)
Male	8	4	Radioactivity (#7), Jupiter (#9)
Reported ethnicity			
Black	6	5	Jupiter (#6), radioactivity (#9)
Latinx	2	2	Jupiter (#8)
White	2	1	Jupiter (#6), telescopes (#9)
Asian	4	0	Jupiter (#5), radioactivity (#7), science (#9)
Other (biracial)	1	1	Jupiter (#7)
Linguistic background			
English only	13	6	Jupiter (#5), radioactivity (#8), science (#10)
Multilingual (received English-language support)	2	3	Jupiter (#7), science (#8)
Educational status			
General education	13	8	Jupiter (#8), radioactivity (#9)
Special education	1	1	Radioactivity (#4), Jupiter (#6), science (#9)
Gifted and Talented Program	1	0	Radioactivity (#1), science (#3)

Prior to individual interviews, all participants completed an interest-ranking task to gauge prior interest in a variety of 20 topics, including but not limited to those relevant to science. This task was used as a conversational anchor during interview conversations.

Interview Conversations

With the goal of more deeply understanding students' perspectives, we employed a conversational, open-ended interview format (see, e.g., Skukauskaite, 2017) that allowed for the flexibility needed for fully capturing participant views within a comfortable setting that positioned the students as experts on their own thinking. As such, each interview session began with an explanation that the interviewer wanted the student's help in making sure that other students of the same age would benefit from reading these texts. Following this explanation was the question, Which book did you prefer, and why? A varied progression of follow-up questions then served to unpack preferences, initially selected from the following menu of possibilities:

- What was familiar?
- What was new?
- What questions do you have about this topic?
- What experiences have you had about this topic?
- What was most/least interesting to you? Why?

Additional prompts to clarify respondents' ideas included these:

- Please tell me more about that.
- Could you explain what you mean about [highlighted term or word from student]?

FIGURE 2
Excerpted Portions From the Science Discovery Narratives "Radioactive Substances" and "Seeing at a Distance"

Radioactive Substances

[Page 2]

By the late 1800s, scientists had already found most of these elements, but some were yet to be discovered. At this time, Polish-born Marie Curie and her French husband, Pierre, were two chemists living in France, trying to find all of Earth's natural elements.

[Page 3]

One day, a fellow scientist named Henri Becquerel showed Marie and Pierre a special kind of rock called pitchblende. When Henri took this pitchblende rock into a dark room, Marie could see that it gave off a light blue glow.

pitchblende

[Page 6]

Like true chemists, Marie and Pierre burned the pitchblende at different temperatures and added different kinds of acid to see what would happen. If they burned the rock too quickly or added too much acid, all of the pitchblende would be gone or destroyed, and they would have to start over again. Marie learned from their experiments that the radioactivity stayed even after many other elements were burned away. She also learned that the radioactivity would not react with most acids.

[Page 10]

While working with excitement and hope for discovering a new element, Pierre and Marie noticed that they were beginning to feel tired and sick. They both saw how their hands began to swell and turn red. Pierre's hair was also starting to fall out, and he thought it might have something to do with the radioactivity. He insisted on being the only one to touch the pitchblende, but it was of no use—even a solid brick wall would not have been enough protection. Marie was beginning to feel the same as Pierre, very tired and unable to eat without vomiting.

Seeing at a Distance

[Page 4]

People during [late 1500s] also believed that the earth was the center of the universe and that everything in space, including the stars and planets, rotated around the earth. Having read the work of Copernicus, Galileo came to wonder whether this was true. Copernicus was a Polish astronomer who argued that the Earth was not the center of the universe, but rather that the stars and planets revolved around the sun.

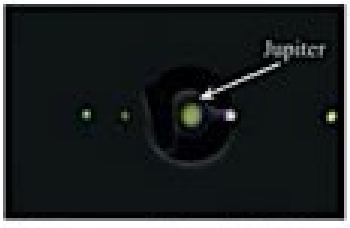
Galileo wanted to learn as much as he could about the night sky. When Galileo heard about a special tool, a "seeing tube" that would allow him to see objects far away, he knew exactly what he wanted to do. He would make a tube of his own that was powerful enough to study the moon and possibly other planets.

[Page 9]

Galileo wanted to make a telescope powerful enough to see clearly into the night sky. He made the tube of his telescope from lead and attached the concave and convex lenses at each end, just like Lippershey. Galileo knew that in order to have lenses powerful enough to see details of objects in space, like the moon, he had to learn how to shape the lenses carefully so that they could refract light in the best way possible.

Telescope with concave and convex lenses.

[Page 13] During Galileo's time, people believed that everything we could see in the night sky moved around the Earth. Galileo wondered if this was true, and so with his mighty telescope, he began to study the planet called Jupiter. Throughout the night, he would make his drawings of Jupiter, taking note of every mark through his powerful lenses.



What we can see through the Galilean telescope.

Two of the 15 students interviewed prior to the experimental study read both SDN and non-SDN versions of "Radioactive Substances" and "Seeing at a Distance"; all other participants read a random selection of two texts.

Each recorded conversation lasted an average of 23 minutes, with a range of 10–35 minutes. A total of 552 minutes of recorded conversations served as the primary data source for this study.

Analytic Framework

We systematically reviewed and analyzed the recorded conversations in three phases. In the first phase, we identified and time-stamped passages of interviews that appeared to indicate, exemplify, or explain opinions or beliefs. Decisions regarding the boundaries of time stamp markers followed van Dijk's (1995/2005) sociocognitive frame for analyzing ideologies expressed in various forms of talk, under the assumption that such talk is grounded in shared values among group members. We investigated the extent to which expressed ideologies converged on common themes across the participants and the extent to which patterns varied across the subgroups identified in Table 1. Our focus on ideological assertions was founded on the theoretical framework by Brown, Reveles, and Kelly (2005), who demonstrated

> that the cultural components of a science classroom, including its language, can generate feelings of cultural conflict for traditionally underrepresented students (Brickhouse, 1994; Brown, 2004; Gilbert & Yerrick, 2001)…[and that] exploring the relationship between language, identity, and classroom learning can provide insights about how students learn to become literate members of a scientific community. (p. 781)

The second phase of analysis involved the construction of thematic codes for grouping time stamp summaries. We initially worked individually in such thematic coding and then compared and discussed these observations; differences between our results were found to be largely lexical (based on word choice) in nature, with few resolutions needed. An example of this discussion comes in reference to the observation of the following comment from J,[1] a seventh-grade student who self-identified as an African American male in a general education program. J was explaining his interest in the SDN version of "Radioactive Substances," which describes the discovery of radium and polonium by Marie Curie and Pierre Curie:

J: Y'know
I really got into **that** one

R: Oh
why was that ↑

J: It was like
I was in the room
y'know
like
I could see what was happening
and it was kinda cool
like I was **there**.

We summarized this portion of the conversation as an ideological assertion regarding preference of text; however, one researcher associated this comment with the theme of relevance, whereas the other used belonging as the thematic label. After several rounds of discussion across randomly selected time stamps, belonging (assertions of membership) was found to be a more appropriate theme that clarified other expressed ideologies sharing the general association of relevance (e.g., familiarity of subject matter). Initially assigned categories for all the responses were fairly consistent across the two separate analyses we conducted, with an inter-rater reliability of above 90%. As exemplified by this transcribed excerpt, thematically coded ideological assertions were transcribed according to how the assertions were uttered, following the general structure of message units (Bloome, Carter, Christian, Otto, & Shuart-Faris, 2004). Phatic displays were captured in bold text, and indications of questioning were marked with an upward arrow (↑) to further contextualize transcribed commentary.

The final stage of analysis involved the construction of a representational landscape of ideological assertions by textual version and by subgroup (see Table 2). Our decision to explore ideologies by general grade level is supported by established understanding of the developmental nature of learning, particularly from text, and the ways that K–12 curricula shape such development (Alexander & Jetton, 2000; Eccles & Roeser, 2011).

Results and Discussion

Table 2 shows the number of participants identified by preference of genre and by grade level who expressed ideologies across the following identified themes: interest of topic, interest in the story, motivation to learn more about the given topic, familiarity of topic, and a sense of belonging or membership with a subject matter or featured scientist. Responses from individuals often indicated more than one of these thematic categories and were coded accordingly. The following response from R, a multilingual eighth grader who self-identified as a Latinx female, illustrates this overlapping:

I liked **that** one ["Radioactive Sunstances," SDN version]
because it was like
a movie in my head ↑
like
I could **see** what they were doing
and
I could get more about
what it means
and what it can do to you

TABLE 2
Expressed Ideological Assertions, by Genre and Grade Level

Theme	Example anchors	SDN	Non-SDN	Grade 6	Grade 7	Grade 8
Topic interest	• "Radioactivity is cool." • "I like stuff about space and planets."	16	6	6	9	7
Story interest	• "I liked how it showed how they got what they're looking for." • "I liked learning about what the scientist did to figure it out."	9	0	3	1	5
Motivation for further research	• "I want to know more about radioactivity." • "Do the moons around Jupiter look like our moon, just more of them?"	9	2	1	2	8
Familiarity	• "I read something about Marie Curie before." • "My uncle has a telescope."	3	2	2	2	1
Belonging/ membership	• "It was like I was in the room." • "I want to make a telescope."	10	0	0	1	9

Note. SDN = science discovery narrative.

it makes me want to know **more**
about that stuff
the **radio**
thing

R indicated that she preferred the SDN version of "Radioactive Substances" over the non-SDN version of "Seeing at a Distance." Both categories of story and topic interest were coupled in her response regarding the reason for her preference. Motivation for further research was also indicated by her stated desire to learn more about the topic of radioactivity.

T, a sixth grader who self-identified as a white male in general education, also read the SDN version of "Radioactive Substances" and provided the following response:

I liked **this** book
because radioactivity is cool
I wish I could see it up close
like
would it burn my hand if I touched it ↑

T's response did not emphasize the story structure; his focus was on the topic itself (indicating the category of topic interest) and his desire to learn more (motivation for further research). Similarly, FA, who self-identified as a Latinx female, explained why the SDN version of "Seeing at a Distance" was more interesting than the non-SDN version of "Radioactive Substances":

The other book was OK
but **this** one ["Seeing at a Distance"]
was more interesting
about the planets
yeah
it was better than the other book
I like planets

Although the majority of participants (18 out of 24; see Table 1) preferred the SDN version of the experimental texts, only half of the participants who stated a preference for the SDN mentioned the story aspects of the text. Clarification for comments that alluded to a preference for longer text (e.g., "there was more information than in radium") generally followed with explanations about concept-specific information (e.g., "it gave me information about space") rather than any mention of the additional structural text needed for the SDNs.

Nine of the 11 participants who indicated a motivation to learn more about the topic preferred the SDN version of the text they saw, which in three cases was "Seeing at a Distance" and in six cases was "Radioactive Substances." The remaining two participants selected the non-SDN version of "Radioactivity Substances" over the SDN version of "Seeing at a Distance," both noting an interest in learning more about the phenomenon. Further, only four participants indicated that their interest had to do with their prior familiarity with the chosen topic.

The Value of SDNs

A major goal of this study was to highlight the directly reported experiences of young people engaging with SDNs and, by triangulating what was learned from conversationally framed interviews with prior scholarship, to begin to construct a theory of what makes SDNs uniquely valuable to developing readers. Interview responses from participants seemed to highlight the utility of texts that foreground personal and sociohistorically contextualized experiences of scientists for comprehending associated conceptual content. As illustrated by results from conversations with the participating students, by foregrounding

the fundamental humanity of science, SDNs may make scientists and their chosen areas of study more relatable and, by extension, more accessible and interesting, hence boosting comprehension.

If one is interested in planets and stars, plants and animals, the human mind and human societies, or any of a large range of other topics, one is already interested in the content of science, whether one identifies it as such or not. From this perspective, the issue facing an educator is not so much to find ways to inspire or create an interest in science but, much more simply, to connect the interests young people already have to communities of practice and their accumulated bodies of knowledge. By emphasizing the contextualized, pragmatic, personal nature of the inquiry process, SDNs humanize science and invite readers to make these connections, which can enhance interest in and attention to the content of science, in turn leading to greater comprehension of scientific concepts.

A comment by J mentioned earlier ("it was like I was in the room") highlights the notion of membership, hence emphasizing a sense of community as a ticket for entry to learning more. Similarly, L, a seventh-grade special education student who self-identified as a white female, expressed such membership through a telling of stargazing with her grandfather:

R: What did you like about this [SDN version of "Seeing at a Distance"] ↑

L: Well
I know about telescopes
cuz my grandfather has one
in his garage
and sometimes
we go out and do stargazing
and like
what I read
was just like what we do
cuz I make drawings too

SDNs also seem to have the ability to challenge notions about what doing science is like, hence inviting awareness that one's prior understanding of phenomena may require revision. Sixth-grade participant FR, who self-identified as a white male and received special education services, expressed his new understanding about the process Marie Curie used to discover two radioactive elements:

FR: I didn't know
how they figured it out
how they got the answer
you know ↑

R: Tell me more
about what you mean

FR: Well
like
they did a bunch of stuff
to get to their answer
they
heated it up ↑
and broke it down to little pieces
I could probably do that
but I don't want to die (laughing)

The apparent surprise in FR's response to the revelation that he too could do the work that Curie did suggested a revision in thinking about one's eligibility to engage in scientific exploration. Such thinking is related to critical reading engagement, which has become a more pronounced issue in the SOR (Hynd, 1999; Milner, 2020).

Reading comprehension and critical engagement are integral to science education, as has been well described by, for example, Hynd and Alvermann (1986) and Pearson, Moje, and Greenleaf (2010). As exemplified earlier, participants noted their reactions to learning more about the scientific process, hence strengthening understanding about what it means to engage in scientific inquiry. The socioculturally situated nature of daily scientific work represented in SDNs is largely invisible to public audiences and absent in school curricula (Irwin & Michael, 2003; Latour & Woolgar, 1979; Viechnicki & Kuipers, 2006). Educational scholars such as Duschl and Bybee (2014) and Dolphin and Dodick (2014) have emphasized the importance of making visible the controversies and political strife that exist within and across scientific communities of practice. The work of these scholars also has echoed that of philosophers and historians, such as Kuhn, Feyerabend, and Lakatos, who emphasized in various ways that discoveries and insights gained by scientists come from a great many sources and are often only peripherally related to the initial goals of the scientists engaged in the work (see, e.g., Schickore, 2018).

In resonance with FR's comment about the events leading to the discovery of radium and polonium, H, who self-identified as an African American female in general education, shared her appreciation of reading more than only conceptual information:

It's like
the books we use ↑
in science class ↑
they do **not**
tell us how they got their answers
an' when I read this book [SDN version of "Radioactive Substances"]
it was like
oh so **that's** what it's like
how you get the answers
that are in the book
but I would read **these** books [points to the SDN]

Whereas most participant responses did not explicitly note the demographic characteristics of the scientists represented in the SDNs, one of the most poignant comments came from M, a sixth grader in general education who self-identified as a white female. In the post-study interview, M, who had recently broken her arm, explained how reading "Radioactive Sunstances" prompted her to share with her doctor during her cast removal her new understanding of radiation emitted from the machine used to take X-rays of her arm. Her conversation with the physician involved safety measures (padded lead coverings) used to protect vital organs during scans. In her response to why she enjoyed the SDN version of "Radioactive Sunstances," M demonstrated a fascination and curiosity regarding how a woman led the process of groundbreaking scientific work:

M: I heard about Marie Curie
but
didn't know that she
that females did science like that
like **really** important science
that saves lives
y'know
I looked her up when I got home ↑
and y'know that
she got two big awards ↑
when people only get one ↑

R: What did you think about that ↑

M: I dunno
hmm
do a lot of females do this kind of science ↑

This response highlights the potential power of SDNs for reaching students across genders and cultural backgrounds. In resonance with the previously discussed studies that demonstrated the importance of the cultural representation of featured scientists, SDNs may have a role in framing science as egalitarian and accessible regardless of demographic background.

Coda: Why Sociohistorical Context Matters

In this study, we explored student perspectives about the ways that SDNs foster greater reading engagement and, hence, comprehension. By so doing, we hope we have also provided an example of how qualitative research, particularly research examining the phenomenology of young people's experiences in interacting with texts, can contribute to the SOR. Participants expressed views that highlighted the importance of the nature and qualities of texts; context matters, especially when the context reveals something relatable to the reader.

A common theme across participant perspectives seemed to be an appreciation for the humanness of scientific exploration and the idea that anyone, including readers, could be scientists. SDNs invited developing readers to understand the sociohistorical beliefs and motivations that led to pursuing particular lines of inquiry, hence bringing reader and scientist closer. This sense of connection could be regarded as a valuable outcome in itself, in addition to being a key component of the ways in which SDNs can lead to improved understanding of the collaborative process of the scientific community. The engagement and interest expressed by the participants suggest that reading comprehension is not optimally fostered in isolation from the dynamic, human, and thus relatable nature of, in this case, knowledge sharing and building and by celebrating the diversity of ways in which individuals have contributed to such knowledge building. Although we acknowledge that the present study was limited in its capacity to explore the full diversity of both reader backgrounds and scientific narratives, it stands to reason that readers from different backgrounds will resonate with different stories and topics, and more explicitly attending to diversity when creating texts could provide more opportunities for readers to personally connect both with the targeted content and the people who brought such knowledge into being.

The sociohistorical context of science has been a major focus of the feminist philosophy of science, which acknowledges the situated nature of knowledge building, the ways in which "dominant conceptions and practices of knowledge attribution, acquisition, and justification disadvantage women and other subordinated groups, and [the need] to reform them to serve the interests of these groups" (Anderson, 2021, para. 1). However, this scholarship has yet to thoroughly make its way into mainstream school standards and curricular materials, including school-based texts. Although the Common Core State Standards (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) emphasize the importance of readers engaging with "literature representative of a variety of periods, cultures, and worldviews" (p. 7), it is unclear to what extent and in what ways this is intended to apply to informational texts, especially those used for learning about science. Furthermore, the only mention of diversity in the Next Generation Science Standards (NGSS Lead States, 2013) can be found in Appendix D (National Research Council, 2013). The examples given of supposedly culturally responsive science teaching seem to exclusively rely on geographic location as a proxy for diversity (e.g., an ecologist working on a conservation project in Nigeria), without mention of the sociocultural identities and political struggles of the scientists themselves. In contrast, SDNs offer contextual information that makes more visible why and how scientists engage in

particular lines of inquiry, which appears to resonate with students on a personal level, as indicated by our interviews.

There remains much to be explored about the optimal uses of sociohistorically contextualized texts for fostering reading practices and (synergistically) content learning vital for success in the 21st century. We believe that future SOR studies would do well to attend to these important contextual matters and how they affect comprehension performance and development. As one example of such work, findings from this study inspired the recent development of community-based programs (e.g., Arya et al., 2017) that focus on connecting young students with the scientific community, as well as a related program for young girls and nonbinary children in a project that positioned them as coauthors of a book about the work of 12 women scientists and engineers (Arya & McBeath, 2018).

Reading comprehension, at the end of the day, is an activity of, by, and for human beings, the motivations for which—curiosity, excitement, ambition, and even enjoyment—are shared by everyone, including developing readers. Based on the voices represented in this study, the SDN appears to provide a powerful means of bringing developing readers closer to professional community practices of learning, offering a means for a reader to feel

> like
> I was in the room…
> like I was **there**.

NOTE

[1] The first letters of surnames are used to protect participants' identity. For those who shared the same initial letter, the last letter of participants' first names are included.

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DIANA J. ARYA (corresponding author) is an associate professor in the Gevirtz Graduate School of Education at the University of California, Santa Barbara, USA; email darya@ucsb.edu. Her research interests focus on the intersection of literacy, knowledge building, and community engagement across K–20 learning contexts.

ANDREW MAUL is an associate professor in the Gevirtz Graduate School of Education at the University of California, Santa Barbara, USA; email amaul@ucsb.edu. His scholarship focuses on the philosophical foundations of the human sciences.