A Framework for Supporting Scientific Language in Primary Grades

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The framework provided in this article for viewing students' science writing offers teachers the opportunity to assess and support scientific language acquisition.

Language and thought are so closely related that it is almost impossible to consider one without the other (Vygotsky, 1934/1986). Like many students, I first learned how to classify trees when I was introduced to a network of named categories and distinctions. My access to knowledge about trees wound through language that included words like *deciduous*, *coniferous*, *simple*, *compound*, and *petiole*; this language functioned to compare categories and describe attributes of trees. My learning in this case was mediated by words; the language of biology determined how I organized my thinking about biology.

To engage in the socially constructed, theoretical, scientific culture, I had to be taught specialized vocabulary to go with my hands-on experience of collecting and examining specimens. In turn, this vocabulary was couched in language that was generalized and abstract, which is characteristic of academic scientific language. Fluency with this language—the ability to flexibly read and write it—was necessary for me to excel in academic science settings. Science is constructed by particular routines of language, and students access scientific ideas through language; after all, people in academic settings routinely use theoretical language to mediate scientific concepts. Thus, students' success in the domain of science is necessarily linked to their fluency with this specialized discourse (Gee, 2004; Lemke, 1990).

In this article, I present a framework for evaluating the written scientific discourse of second- and third-grade students. Out of necessity, this framework consists of concepts that are mediated by terms and named categories that may be new to the reader. This introduction to the language of such a framework may influence the way you understand students' attempts to write in science and the way you support them in that endeavor.

Fluency in the Domain-Specific Language of Science

When students come to school, they are already fluent in many discourses: the language of play, the language of family festivals, the language of eating, and so forth. In the classroom, students are confronted with new, academic discourses. Academic scientific discourse represents a distinct way of knowing and thinking (Gee 2004; Halliday & Martin, 1993; Lemke, 1990; Ogborn, Kress, Martins, & MacGillicuddy, 1996), and therefore a particular language for conveying ideas to others (Goldman & Bisanz, 2002; Halliday & Martin, 1993).

Specifically, research has shown that academic scientific texts express scientific ideas that are canonical and theoretical in nature, referring to general classes of objects rather than particular ones, and these texts tend to emphasize relationships of classification and logical connections among general terms and processes (Lemke, 1990). Unlike narrative or everyday discourses, academic scientific discourse is characterized by elements such as topic presentations, descriptions of attributes, characteristic events, category comparisons, experimental

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ideas, results, final summaries, (Pappas, 2006), and explanation (Lemke, 1990; Ogborn et al., 1996), as well as linguistic characteristics such as general nouns, present tense verbs, nominalization, and technical vocabulary (Halliday, 2004; Halliday & Martin, 1993; Hasan, 1985). Furthermore, academic scientific texts are written from an authoritative distance from the reader (Christie, 1989) in a serious register (Wollman-Bonilla, 2000) that precludes the use of familiar, everyday language. Facts are presented objectively, without explicit evidence of the author's opinion of the value of the facts.

PAUSE AND PONDER

- How can you promote multimodal engagement with content area language?
- What kinds of texts would support multimodal engagement with content area language?

Although scientific discourse may be new and challenging to some students, it is not the case that young students are unable to learn informational discourses, nor is it the case that they find such discourse to be off-putting. Research shows that young students respond to and take up informational discourses quite readily when socially supported in those discourses (Pappas, 1993); however, many students do not come to school with this fluency. Further, the intense focus on decoding in primary curricula has relegated instruction in informational literacies to a marginal role in classroom schedules.

Fluency in a specialized language such as scientific discourse involves receptive knowledge and expressive knowledge of linguistic patterns and words. *Receptive knowledge* refers to students' ability to understand, to some extent, the word when they hear or read it. *Expressive knowledge* refers to the students' ability to *use* the term in speech or writing to communicate scientific ideas. Often in classroom instruction, receptive knowledge receives more instructional focus than does expressive knowledge. For one thing, there is more focus on reading and comprehending than on talking and writing. In addition, it is a more complex endeavor to measure (test) expressive knowledge than receptive knowledge. Typically assessment of language is limited to measuring students' ability to define vocabulary terms or to select a correct definition from four distracters, and such assessment does not directly address students' ability to *use* particular vocabulary to communicate ideas. The focus of this article is on the measurement and support of students' expressive fluency with scientific discourse, their ability to *use* the specialized vocabulary and language structures of science, specifically in writing.

Scientific Discourse in Integrated Science/Literacy Instruction: An Example

In language-rich classroom communities in which teachers integrate reading and writing with hands-on science activities, students readily take up the scientific discourse in which they are immersed. In one case (Honig 2007, in press), two teachers and their respective multiage (grades 2 and 3) classes coconstructed a scientific discourse that functioned to communicate data-level ideas (referring to concrete objects at hand) as well as theoretical ideas (referring to general principles and general classes of objects). Students and teachers communicated such ideas through linguistic elements such as description of attributes, characteristic events, results, and explanation. Students were immersed in a classroom context that included extensive dialogue around hands-on activities, reading of informational science trade books, and various writing activities.

In this literacy-rich context, students participated in various forms of scientific writing: They quickly jotted notes following a hands-on activity; they wrote sticky note summaries of main ideas following small-group reading of an informational book; they coconstructed class charts summarizing scientific concepts; they filled out experiment sheets (scientific method sheets) documenting hypotheses, results, and conclusions of a hands-on activity; they drew concept maps; they constructed graphic organizers; they individually wrote end-of-unit books; and they collaborated with peers to produce end-of-unit research reports.

Scientific writing was highly scaffolded in this context by the teachers. Teachers' directions, modeling, and comments during discussion included explicit examples of what to write about ("You have to answer the question."), what words to use ("You would probably want to say 'I think....'"), how to consider the audience ("You don't want the reader to think this is boring."), and why to write ("So that you will remember."). In most cases, writing activities were preceded by sessions of group sharing in which class charts of writing ideas were coconstructed by teacher and students. Students were intentionally immersed in multimodal aspects of the language of science.

Students in these classrooms participated in a hands-on demonstration in which they created a vortex by spinning tea leaves in a vase of water. This demonstration was intended to serve as a metaphor that could explain the constant storm, or the Great Red Spot, on Jupiter's surface. Classroom discussion included data-level discourse about the spinning tea leaves as well as theoretical discourse about the connection to the theoretical spinning particles on Jupiter's surface. Following the discussion, students were asked to write and illustrate what they had learned about Jupiter's constant storm. Students worked alone and finished in about 20 minutes.

In the next section I provide examples of students' artifacts. I begin by discussing the kinds of ideas the students expressed. Using Pappas's (2006) framework of global elements for expository text, I found evidence of several types of ideas that students expressed in their writing.

In addition to the ideas expressed by students, I also describe the linguistic (i.e., tense, general versus particular nouns) and lexical (i.e., use of specialized vocabulary) nature of their work. As stated previously, scientific language is domain-specific; therefore, to assess and support students' acquisition of this language, a framework is needed that authentically reflects its domain-specific nature.

Examples of Students' Texts: Types of Ideas, Grammar, and Vocabulary

In this section, I provide five examples from the texts of 36 students, and I discuss them according to a framework that accounts for the scientific ideas represented in students' written texts, and the linguistic nature of students' attempts (see Table 1).

Grammatical and Lexical Nature of Results. Six students wrote about the results of the hands-on tea-leaf activity by using data-level scientific discourse, characterized by past tense verbs (e.g., *when we spun*), particular nouns (e.g., *the tea flakes*), and some specialized vocabulary (e.g., *vortex*) to describe the actual science event in which they participated. Here is an example of what one student wrote:

> When we spun the tea flakes and water it caused a vortex and it looked like a tornado.

Grammatical and Lexical Nature of Description of Attributes. Eleven students wrote description of attributes by using present or timeless tense (e.g., *it is a*), nouns that refer to decontextualized or theoretical entities (e.g., *constant storm*), and some specialized vocabulary (e.g., *vortex*) to describe the attributes of Jupiter, a theoretical entity. Here is an example of a written description of attributes:

> I learned about the red spot on Jupiter. It is a constant storm. The gas swirls around and makes a vortex.

Grammatical and Lexical Nature of Results Linked to Characteristic Events. Thirteen students explicitly linked results of the hands-on activity to characteristic events on a theoretical Jupiter by using a combination of registers: (a) data-level discourse, characterized by past tense, particular nouns, and some specialized vocabulary to describe the tea-leaf event in which they participated and (b) theoretical discourse, characterized by timeless tense, the use of theoretical (not observable) nouns and some

Table 1
Types of Ideas Represented in Students' Texts

Grade	*N*	Results	Description of attributes	Results linked to characteristic events	Explanation	Explanation and question
2	19	5	5	6	2	1
3	17	1	6	7	3	0
Total	36	6	11	13	5	1

specialized vocabulary to describe what theoretically happens on Jupiter. In addition, these students typically used phrases such as *this is just like* or *this represents* to describe the link between the hands-on activity and theoretical Jupiter. Here is an example of written results linked to characteristic events:

> When we twirled the pencil in the water and tea leaves it started to make a tornado which is a vortex. The vortex sucked the tea leaves. The swirling gases is what makes the storm on Jupiter.

Grammatical and Lexical Nature of Explanation. Five students wrote explanations by using timeless tense verbs, nouns that represent abstract entities, and some specialized vocabulary to explain a theoretical idea. Students typically used conjunctions such as *because* to construct explanations of cause and effect relationships. Here are two examples of a written explanation:

> On Jupiter the gases caused a swirling vortex and sucked up particles causing a constant storm.

> Do you want to know what that red spot is on Jupiter? Well I'll tell you. The red spot is a constant storm. The constant storm has never stopped since a man from earth saw it. "I don't know why it hasn't gone away so please don't ask me." I saw how the storm forms with this awesome activity. The storm forms because all of the dust connects because of the gas swirling to make a vortex.

Grammatical and Lexical Nature of Explanation Linked to Further Question. One student wrote an explanation linked to a further question by using timeless tense, general nouns, and some specialized vocabulary to explain and wonder about a theoretical idea. Here is an example of a written explanation linked to a further question:

> Today in science we did an experiment to see what is happening on Jupiter's red spot. We found out that the red spot is actually a vortex that I'm wondering if it really does black hole things like suck things into it, bend light, and minimize things that go into it.

A Closer Look at Grade, Ideas Expressed, and Vocabulary Usage

In summary, the students writing about Jupiter's Great Red Spot functioned to express four distinct types of meanings, or ideas—(1) results, (2) description of attributes of Jupiter, (3) results linked to characteristic events on Jupiter, and (4) explanation of Jupiter's Great Red Spot. The teachers' goal was for students to understand the constant storm on Jupiter and "how it works," so they rated students' artifacts in a way that favored links between the classroom activity and the constant storm or explanations of the constant storm. Therefore, the ideas represented in students artifacts were graded according to this order, from lowest to highest: (1) results (in which students wrote about what happened to the tea-leaf vortex), (2) description of attributes of Jupiter (in which students reported that there is a vortex on Jupiter's surface), (3) results and characteristic events of the storm on Jupiter (in which students wrote about the tea-leaf vortex and reported that this is what is happening on Jupiter), and (4) explanation (in which students explained the cause of the constant storm).

Among these 36 second and third graders, a student's grade level was not significantly related to the scientific nature of the writing in terms of ideas, vocabulary density, or vocabulary range. This suggests that a student's ability to appropriate scientific discourse in writing may be amenable to social influences. Further, a closer look at the vocabulary used in various artifacts reveals that the range and density of specialized vocabulary in a student's text were more related to the type of idea a student wrote about than the grade level (see Tables 2 and 3). Both second and third graders who wrote descriptions of attributes of Jupiter used more specialized vocabulary than did students who wrote results, and students who wrote an explanation used more specialized vocabulary than did students who wrote a description of attributes. Therefore, there may be a link between a student's ability to use domain-specific vocabulary and the ability to express particular kinds of scientific ideas.

A Framework for Assessing Students' Scientific Language

Scientific discourse represents a distinct language and, as such, is relevant to students' academic success. To understand how students develop fluency in the domain-specific discourses of science, a framework is needed for evaluating students' attempts to comprehend and produce domain-specific language. It may not be sufficient to evaluate science writing according to widely used characteristics such

Table 2
Average Range (Distinct Words) of Specialized Vocabulary in Students' Written Texts

Grade	*N*	Results	Description of attributes	Results linked to characteristic events	Explanation	Explanation and question
2	19	1.7	3.6	4.0	7.5	7.0
3	17	1.0	2.4	5.0	7.4	NA
Total	36	1.5	3.3	4.5	7.4	7.0

Note. Correlation between Idea Type and Range: Pearson's $r = .735$, $p < .01$.

Table 3
Average Density (Percentage) of Specialized Vocabulary in Students' Written Texts

Grade	*N*	Results	Description of attributes	Results linked to characteristic events	Explanation	Explanation and question
2	19	4.0%	21.0%	12.8%	40.5%	21.0%
3	17	3.0%	10.7%	15.4%	32.0%	NA
Total	36	4.0%	15.0%	14.0%	34.0%	22.0%

Note. Correlation between Idea Type and Density: Pearson's $r = .495$, $p < .01$.

as organization or inclusion of supporting details. As the previous examples illustrate, scientific discourse functions to communicate particular kinds of ideas. Further, theoretical scientific discourse entails fluency with specialized vocabulary. Teachers can evaluate students' scientific writing by attending to the types of scientific ideas students express, the linguistic nature of their writing, and the extent to which they use scientific vocabulary correctly.

To illustrate what this might look like, I have included an example of a writing rubric used in an integrated thematic unit on the life cycle of a seed plant. First, in the design of the unit, student-friendly *I can…* statements related to writing about plants were constructed for two state science standards (see Table 4). Next, a rubric was constructed that could be used to evaluate student writing (see Table 5).

A Framework for Supporting Students' Scientific Language

Once teachers have established a framework for evaluating their students' attempts at written fluency in scientific discourse, teachers will gain awareness of their students' needs and progress in acquisition of this domain-specific language. Then, and most important, teachers can promote this language by providing multiple, multimodal instructional experiences. Teachers can provide opportunities for students to engage in scientific discourse by immersing them in the language of science, modeling the language, providing authentic purposes that encourage students to take responsibility for their engagement, providing feedback, practice, and opportunities for approximations. In fact, these characteristics of scaffolded instruction reflect a prominent model of vocabulary learning (Nagy & Scott, 2000).

According to this model, knowledge of particular words is incremental, and deepens over multiple exposures to texts, teacher modeling, and classroom discussion. Word knowledge is also multimodal, and involves use of the word in writing, speaking, doing, listening, and reading. Word knowledge is interrelated, so knowledge of a seed coat influences our knowledge of seeds. Word knowledge is heterogeneous, so knowing the meaning of *pollinate*

Table 4
State Standards and Corresponding *I Can…* Statements

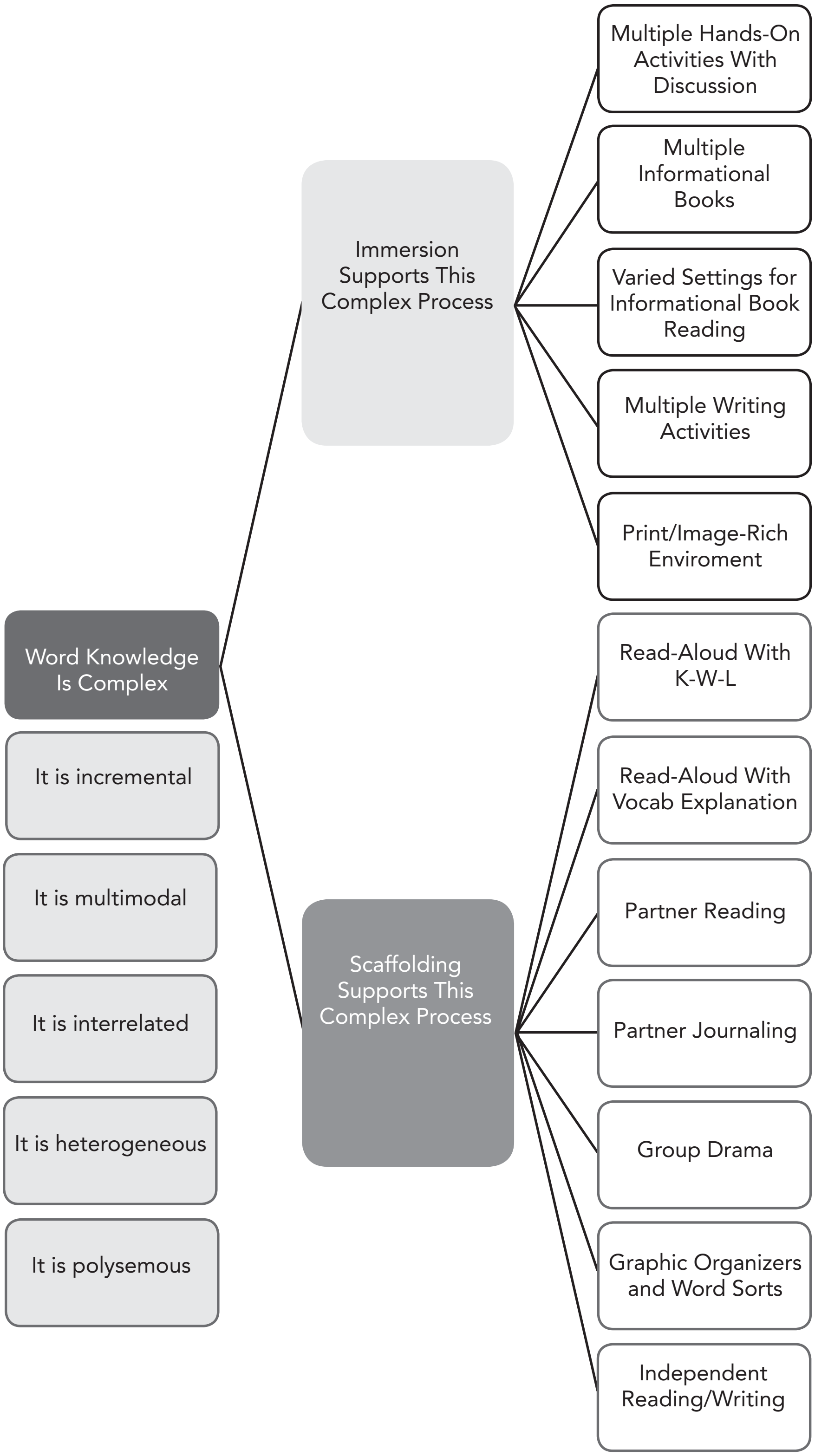
State standard	*I can…* statements
12A: Know and apply concepts that explain how living things function, adapt, and change.	■ I can **describe attributes** of seed plants. ■ I can **describe characteristic events** in the life cycle of a seed plant. ■ I can **compare and contrast** different types of seed plants. ■ I can **compare and contrast** plants with other living things.
12B: Know and apply concepts that explain how living things interact with each other and the environment.	■ I can **explain** the life cycle of a seed plant. ■ I can **explain** how plants fit into the food chain. ■ I can **explain** how seed plants contribute to their ecosystem.

Table 5
Rubric for Evaluating Scientific Writing About Plants

When writing informational text on plants	Working on	Meets	Exceeds
Describes attributes of plants	■ Minimal quantity ■ Inconsistently accurate ■ Needs teacher assistance	■ Adequate quantity ■ Mostly accurate ■ Minimal teacher assistance	■ Thorough explication ■ Mostly accurate ■ Independent
Describes characteristic events	■ Minimal quantity ■ Inconsistently accurate ■ Needs teacher assistance	■ Adequate quantity ■ Mostly accurate ■ Minimal teacher assistance	■ Thorough explication ■ Mostly accurate ■ Independent
Compares categories	■ Minimal quantity ■ Inconsistently accurate ■ Needs teacher assistance	■ Adequate quantity ■ Mostly accurate ■ Minimal teacher assistance	■ Thorough explication ■ Mostly accurate ■ Independent
Explains the life cycle of the seed plant	■ Articulates isolated parts of life cycle	■ Articulates main points of life cycle and explains the links between points	■ Thorough explication, extending to other theories and phenomena
Explains role in ecosystem	■ Articulates isolated parts of ecosystem	■ Articulates main points of ecosystem and explains the links between points	■ Thorough explication, extending to other theories and phenomena
Uses specialized vocabulary	■ Specialized vocabulary is rarely used accurately	■ Specialized vocabulary is occasionally used accurately	■ Specialized vocabulary is frequently and accurately used

is inherently different than knowing the meaning of *stamen*. Finally, word knowledge is polysemous, so the individual words can be used flexibly to take on multiple shades of meaning. The aspects of interrelatedness, heterogeneity, and polysemy of word knowledge are supported by exposure to vocabulary via multiple texts and settings, graphic organizers, and word sorts. Figure 1 provides examples of scaffolded instructional applications that reflect this model of vocabulary knowledge.

Figure 1
Instructional Activities That Support Word Knowledge and Language Development



Language Enriched Science Instruction: The Life Cycle of a Seed Plant

The following instructional activities were used by Lisa, a teacher of second graders, in a unit on the life of a seed plant. These activities involve explicit word explanations as well as multimodal use of scientific vocabulary in the expression of scientific ideas such as description of attributes, category comparison, and so forth. In these activities, students had abundant multimodal opportunities to engage in both theoretical and data-level language, using domain-specific vocabulary. Importantly, such instruction illustrates the intentional focus on the domain-specific nature of academic scientific language found in informational books.

Vocabulary Visits. Using vocabulary visits (Blachowicz & Obrochta, 2005), Lisa displayed a large poster that included multiple images of plants. Students brainstormed domain-specific vocabulary unique to the images. In other words, students were encouraged to include words like *seed* and *pollen* rather than everyday words like *green* or *big*. Lisa wrote the words they suggested on individual sticky notes, and the students chose a logical placement of the sticky note on the chart. As work continued, sticky notes were rearranged and grouped according to semantic links the students made. Throughout the unit, this poster was revisited, added to, and reorganized as needed. After the unit, the poster remained on display as an artifact of this domain to which students added throughout the year.

Read-Aloud of Informational Trade Books and K-W-L. A K-W-L activity (Ogle, 1986)—in which students first record what they know and what they want to know about plants—before Lisa's read-aloud offered opportunities for students to say, hear, and see scientific language. Lisa modified this activity by grouping the student ideas on the chart according to type (i.e., description of attributes and so forth). As read-aloud progressed, students also added new domain-specific words to the vocabulary visit poster, and Lisa offered explanations of the words. After reading, students shared ideas that they learned from the text to complete the K-W-L activity. These ideas were grouped in the *L* section of the chart according to type as was done with what the students knew and what they wanted to know.

Hands-On Activities. Multiple hands-on activities with seeds and plants included the following: (a) placing seeds inside plastic baggies with wet paper towels and observing seed coats splitting and root growth, (b) planting seeds inside clear cups so that roots were visible for observation, and (c) planting grass to observe the grass going to seed. During such activities, Lisa encouraged partners to share their observations aloud so that students would use data-level language and specialized vocabulary to describe the growth of their plants.

Journal Writing. Journal entries provided a place for recording data-level language about hands-on activities as well as theoretical language about ideas from books that Lisa or the students read. Journal writing was always preceded by partner talk and preplanning for the purpose of providing oral rehearsal of ideas. Journal entries were read to partners for further engagement with scientific discourse.

Partner Reading of Multiple Trade Books. The availability of multiple informational trade books promoted multiple exposures to technical vocabulary and offered choice to students. Selection of such books included consideration of the presence of scientific discourse. Although narrative texts can be included, Lisa chose a wide variety of books (47 titles) that expressed scientific language to support such language acquisition. Lisa provided books' reading levels as a guide, but did not restrict students' choices. Early in the unit, pairs of students enjoyed browsing many books, scanning them for interesting information. As the unit progressed, students were encouraged to focus on one or two books per session. As students read alongside their partners, they stopped to share interesting information. Table 6 illustrates the way these instructional activities were organized in a unit.

Conclusion

Fluency in scientific discourse is necessary for success in school science. Success in school science leads to opportunities for careers in science. Students come to school fluent in many discourses; indeed, some come to school fluent in informational language. There is, certainly, a robust effort in primary classrooms to build narrative discourse—frameworks exist that highlight beginning, middle,

Table 6
Four Days From Unit, "Life Cycle of the Seed Plant"

Day	Instructional activity	Language focus
Day 1	**Vocabulary visit** ■ Display plant poster with multiple images ■ Brainstorm vocabulary words that reflect images ■ Teacher write each word on sticky note ■ Students place sticky notes on poster ■ As work continues, sticky notes may be grouped according to semantic links	■ Domain-specific vocabulary
	Read-aloud: Informational trade book 1 ■ Record prior knowledge onto a K-W-L chart ■ Set purpose for reading with K-W-L chart ■ As teacher reads, students listen for more words to add to the poster ■ Teacher provides explanation of words	■ Domain-specific vocabulary ■ Theoretical language: Description of attributes Characteristic events Category comparison Explanation
	Response to literature ■ As students share learned information for K-W-L chart, teacher records each response by organizing responses as description of attributes, characteristic function, or explanation.	■ Domain-specific vocabulary ■ Theoretical language: Description of attributes Characteristic events Category comparison Explanation
Day 2	**Vocabulary visit** ■ Distribute sticky notes ■ Students sort them onto poster	■ Domain-specific vocabulary
	Seed planting ■ Discussion during hands-on activity	■ Domain-specific vocabulary ■ Data-level language: Observation of results
	Journal writing ■ With a partner, plan journal entry about seed planting ■ Write journal entry and read to partner	■ Domain-specific vocabulary ■ Data-level language: Observation of results
Day 3	**Read-aloud: Informational trade book 2** ■ Record prior knowledge onto a K-W-L chart ■ Set purpose for reading with K-W-L chart ■ As teacher reads, students listen for more words to add to the poster ■ Teacher provides explanation of words	■ Domain-specific vocabulary ■ Theoretical language: Description of attributes Characteristic events Category comparison Explanation
Day 4	**Read-aloud: Informational trade book 3** ■ Record prior knowledge onto a K-W-L chart ■ Set purpose for reading with K-W-L chart ■ As teacher reads, students listen for more words to add to the poster ■ Teacher provides explanation of words	■ Domain-specific vocabulary ■ Theoretical language: Description of attributes Characteristic events Category comparison Explanation
	Partner reading: Informational trade books ■ Students select from multilevel informational trade books and explore books with partners	■ Domain-specific vocabulary ■ Theoretical language: Description of attributes Characteristic events Category comparison Explanation
	Journal writing ■ With a partner, plan journal entry about text read ■ Write journal entry and read to partner	■ Domain-specific vocabulary ■ Theoretical language: Description of attributes Characteristic events Category comparison Explanation

and end as well as setting, characters, conflict, and resolution (Pappas, 1993).

Informational discourses must be better supported in the primary grades, especially since the decontextualized and theoretical language of science texts becomes increasingly central in mediating scientific knowledge in intermediate and middle school years. Research has shown that informational text is not too difficult nor too off-putting for young students and that they acquire languages in which they are socially supported (Moss, Leone, & Dipillo, 1997; Pappas, 1993; Smolkin & Donovan, 2001). The framework provided in this article for viewing students' science writing essentially offers teachers a language for the assessment and support of students' scientific language acquisition. Its value lies in the potential for educators to use such a framework to support the full participation of all students in the field of science.

References

Blachowicz, C.L.Z., & Obrochta, C. (2005). Vocabulary visits: Virtual field trips for content vocabulary development. *The Reading Teacher*, *59*(3), 262–268. doi:10.1598/RT.59.3.6

Christie, F. (1989). Language development in education. In R. Hasan & J.R. Martin (Eds.), *Language development: Learning language, learning culture* (pp. 152–256). Norwood, NJ: Ablex.

Gee, J.P. (2004). Language in the science classroom: Academic social languages as the heart of school-based literacy. In W. Saul (Ed.), *Crossing borders in literacy and science instruction: Perspectives on theory and practice* (pp. 13–32). Arlington, VA: National Science Teachers Association.

Goldman, S.R., & Bisanz, G.L. (2002). Toward a functional analysis of scientific genres: Implications for understanding and learning processes. In J. Otero, J.A. Leon, & A.C. Graesser (Eds.), *The psychology of science text comprehension* (pp. 19–50). Mahwah, NJ: Erlbaum.

Halliday, M.A.K. (2004). *An introduction to functional grammar.* Baltimore: Arnold.

Halliday, M.A.K., & Martin, J.R. (1993). *Writing science: Literacy and discursive power.* Pittsburgh, PA: University of Pittsburgh Press.

Hasan, R. (1985). The structure of a text. In M.A.K. Halliday & R. Hasan (Eds.), *Language, context, and text: Aspects of language in a social-semiotic perspective* (pp. 52–69). Deakin, Australia: Deakin University Press.

Honig, S.L. (2007). *Learning to write in science in the primary grades: A contextual study.* Unpublished dissertation, University of Illinois, Chicago.

Honig, S.L. (in press). What do children write in science? A study of the genre set in a primary science classroom. *Written Communication.*

Lemke, J.L. (1990). *Talking science: Language, learning, and values.* Norwood, NJ: Ablex.

Moss, B., Leone, S., & Dipillo, M.L. (1997). Exploring the literature of fact: Linking reading and writing through information trade books. *Language Arts*, *74*(6), 418–429.

Nagy, W. & Scott, J. (2000). Vocabulary processes. In M.L. Kamil, P.B. Mosenthal, P.D. Pearson, & R. Barr (Eds.), *Handbook of reading research* (Vol. 3, pp. 269–284). Mahwah, NJ: Earlbaum.

Ogborn, J., Kress, G., Martins, I., & MacGillicuddy, K. (1996). *Explaining science in the classroom*. Bristol, PA: Open University Press.

Ogle, D.M. (1986). K-W-L: A teaching model that develops active reading of expository text. *The Reading Teacher*, *39*(6), 564–570

Pappas, C.C. (1993). Is narrative "primary"? Some insights from kindergarteners' pretend readings of stories and information books. *Journal of Reading Behavior*, *25*(1), 97–129.

Pappas, C.C. (2006). The information book genre: Its role in integrated science literacy research and practice. *Reading Research Quarterly*, *41*(2), 226–253.

Smolkin, L.B., & Donovan, C.A. (2001). The contexts of comprehension: The informational book read aloud, comprehension acquisition, and comprehension instruction in a first-grade classroom. *The Elementary School Journal*, *102*(2), 97–122. doi:10.1086/499695

Vygotsky, L.S. (1986). *Thought and language* (A. Kozulin, Trans.). Cambridge, MA: MIT Press. (Original work published 1934)

Wollman-Bonilla, J.E. (2000). Teaching science writing to first graders: Genre learning and recontextualization. *Research in the Teaching of English*, *35*(1), 35–65.

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