Scientific Literacy and Commercial Reading Programs: An Analysis of Text and Instructional Guidance

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We present data on the amount and nature of the scientific text contained in three of the most widely used commercial reading programs in grades 1 to 6 in Canada and an analysis of the guidance for reading instruction that accompanies such texts. These reading programs claim to be sequential and developmental and to have science as one of their instructional foci. In our highly technological and information-based society, the capacity to read informational texts carefully and critically is increasingly important. This ability is germane to the acquisition of scientific literacy (Norris & Phillips, 2003), although little instruction in the reading of scientific texts occurs in elementary science lessons, which are currently heavily oriented towards hands-on learning (Heselden & Staples, 2002). Fostering the ability to read and write scientific text generally falls to teachers who provide reading instruction, often through the use of commercial programs.

The student texts of commercial reading programs have long been the mainstay for elementary reading instruction in North America. Although formerly dominated by narratives (Flood & Lapp, 1987; Moss & Newton, 2002; Murphy, 1991), publishers now include more texts with informational qualities (Phillips, Smith, & Norris, 2005). Some of these programs contain explicit claims to include scientific content accompanied by instructional guidance for literacy teachers. Thus, commercial programs convey an impression of usefulness for teaching students to read scientific texts, but their potential for doing so is largely unexplored.

Background

Scientific literacy is a broad and widely used term with many shades of meaning. Recently, however, interactions between the literacy and science education communities have led to some elucidation of the role of language in science learning (Saul, 2004; Yore et al., 2004). Norris and Phillips (2003), for example, argued that there are two distinct senses of scientific literacy: a *fundamental* sense, meaning the ability to read and write science text; and a *derived* sense, referring to being knowledgeable, learned, and educated in science. Although it is the second of these senses that is more prominent in science education, some attention has been paid to the fundamental sense of the term (e.g., Anderson, 1999; Heselden & Staples, 2002; Millar & Osborne, 1998). Often, however, it is the functional relationship between literacy and science that is highlighted. As an alternative, Norris and Phillips (2003) advanced the view that reading and writing do not stand merely in a functional relationship with respect to science, as simply tools for the storage and transmission of science. Rather, the relationship is also a constitutive one, wherein reading and writing are essential components of science. Reading science text means comprehending, interpreting, analyzing, and critiquing it. Explicitly teaching students how to read science t this manner goes beyond what traditionally has fallen under the rubric of scientific literac attempts to foster capacities for dealing with scientific expertise (Norris, 1995, 1997).

Existing research suggests that it is rare for extended reading or reading instruction to b of science lessons (Heselden & Staples, 2002; Wellington & Osborne, 2001). One explan for this absence lies in teachers' perceptions of science education and their knowledge science. Educational practices depend to a large extent on the values and knowledge c teacher (Abell & Roth, 1992; Brickhouse, 1990; Pomeroy, 1993), and values may be an stronger predictor of behavior than knowledge as far as program implementation is conc (Pajares, 1992). Elementary science teachers have widely embraced a constructivist philo that emphasizes first-hand and student-centered learning, hands-on activities, and the foster positive attitudes toward science (Levitt, 2001). Although the importance of active particip in learning science should not be underrated, the convergence of evidence suggests th fundamental sense of scientific literacy has been largely ignored in recent decades of s education. A possible reason is reading and text are generally associated with older, tradi methods of instruction, which are viewed as passive and ineffective for learning science co (Tobin, Tippins, & Gallard, 1994). According to Palinscar and Magnusson (2001), text is neglected when teachers embrace "activity-based, project-driven, or guided inquiry practic 152) and attention to text has come mainly from the reading education community rathe the science education community.

If little instruction in the reading of scientific texts occurs in elementary science less is quite probable that fostering the fundamental sense of scientific literacy falls to teacher provide reading instruction. Commercial reading programs, which provided the dominant ma used for reading instruction throughout most of the 20th century (Dole & Osborn, 2003; S Phillips, Leithead, & Norris, 2004), are still pervasive in literacy classrooms, and evidence su that many teachers rely on them for much of their reading instruction (Morrow & Gambrell, Thus, it is important to investigate the extent to which commercial reading programs are de to support the teaching of scientific literacy.

The content of commercial reading programs has changed considerably over the past decades. The literature-based movement of the 1980s had a significant effect on basal r programs in the United States (Cullinan, 1987; McCarthy et al., 1995) as the call for t of authentic children's literature in classrooms resulted in publishers producing anthologi purportedly included a good deal of unabridged, original, and/or authentic children's lite (Hoffman et al., 1994; McCarthy et al., 1995; Reutzel & Larsen, 1995). More recently, foll the height of the literature-based movement in literacy education, there have been numero for the inclusion of more informational text in children's reading instruction (Christie, 1987; 2000; Pappas, 1991). Content analyses of basals have shown a narrative or literary emphasis & Lapp, 1987; Moss & Newton, 2002; Murphy, 1991), but more recent research indicat publishers have responded to the push for inclusion of more non-fiction and information in literacy instruction (Phillips et al., 2005). Today's programs contain a variety of genres, s which have science content.

Along with the changing content of the student texts, the instructional guidance provided in the teachers' manuals has evolved and been shaped by developments in the literacy field. There are few contemporary analyses of this content, however, and the usefulness of this guidance for fostering the fundamental sense of scientific literacy remains unknown. This study thus had a dual purpose: (a) identification and quantification of the scientific texts that are included in widely used programs, and (b) examination of the nature and quality of reading instruction associated with these texts.

METHOD

Data Sources

Canada's most widely used commercial reading programs were identified by the Ministries of Education in all ten provinces and three territories. At least one of the following programs was identified by each jurisdiction: (1) *Cornerstones Canadian Language Arts* by Gage (1998-2001), (2) *Collections* by Prentice Hall Ginn Canada (1996-2000), and (3) *Nelson Language Arts* by Nelson Thomson Learning (1998-2001). Henceforth, we refer to these as Gage, Ginn, and Nelson.

Complete program sets were obtained from the publishers. Each program set contained at least two student books (anthologies) for each grade, with a total of 72 student books among the three publishers, teachers' guides, and a variety of ancillary materials. We inventoried the contents of the student books by selection and the accompanying teachers' guides in terms of the instructional materials intended for use with each selection. We refer to these selections plus their associated instructional materials as instructional sets. Table 1 shows the total number of selections (in the student books) and instructional sets (in the teachers' guides) and their distribution by grade and publisher. There is a discrepancy between the numbers of selections and instructional sets because some instructional sets were built around more than one selection. For example, several poems or newspaper articles may jointly have been the focus of an instructional set, although for the most part, a single selection (story or expository piece) in the student book was associated with a single instructional set in the teachers' guide. The first part of this investigation identified the subset of

Table 1. Number of Selections and Instructional Sets by Grade and Publisher

Grade	Publisher							
	Gage		Ginn		Nelson		Totals	
	Sel.	Sets	Sel.	Sets	Sel.	Sets	Sel.	Sets
1	64	61	49	49	47	44	160	154
2	58	57	51	50	52	48	161	155
3	49	48	72	67	47	41	168	156
4	68	53	86	67	53	52	207	172
5	59	54	83	68	66	53	208	175
6	60	52	85	73	57	43	202	168
Total	358	325	426	374	322	281	1106	980

selections that contain science content, and the second part examined the reading guidance in instructional sets.

Identifying Selections with Science Content

We began identification by applying the following question to each selection: Does text contain information related to science and/or technology? To develop criteria for qualify selections, we reviewed Benchmarks for Scientific Literacy (American Association for Advancement of Science [AAAS], 1993), Science for All Americans (AAAS, 1994), the National Science Education Standards (National Research Council, 1996), and the Common Framework Science Learning Outcomes K to 12 (Council of Ministers of Education Canada, 1997). Of the the National Science Education Standards was selected as a source of criteria because it included the clearest and most concise set of statements ordered into easily distinguishable categories and subcategories. For example, the category Physical Science contained the subcategories Properties Objects and Materials; Position and Motion of Objects; Light, Heat, Electricity; and Magnetism. We used the content standards statements for kindergarten to grade 4 and selected statements for grades 5 to 8. In making decisions about content, illustrations were taken into consideration. Selections containing unrealistic illustrations (smiling ants, for example) were not considered representative of scientific writing.

The process of classifying selections (1106 in total) involved several steps. Three categories were utilized: "yes" (selection contains scientific content), "no," and "maybe" (uncertainty to whether the text can be considered scientific content). Initially, about 7% of selections (were classified as "maybe." Included here were selections containing very limited science content (often only one sentence); indirect reference to science or technological concepts (predominantly presented in illustrations); or writing about science that seemed inaccurate or misleading, or that incorporated fanciful elements that made the scientific content difficult to interpret (e.g., referring to animal habitats as homes or indicating that close-up photographs of objects represented the way a caterpillar's eyes would view those objects).

Refinement of classification was the next step and took place in an iterative manner by discussing categories among three investigators, applying precision to the wording of criteria statements, establishing percentage ranges for estimating the amount of scientific content, and identifying the type of science content in each selection by category and subcategory. After developing the procedures for classification, two investigators independently read and categorized the entire set of 1106 selections. Agreement was found for 91% of the selections and the 98 differences were resolved through discussion. This process reduced the number of "maybe" selections to six, with 232 selections identified as clearly containing science content for a total of 238 science selections examined.

Unit of Analysis for Instructional Guidance

Although student books contained some instructional directions, we found that almost all such instruction was also included in the accompanying teachers' guide along with additional instruction. The instructional guidance associated with the 238 science selections was contained in 233 units of instructional materials in the teachers' guides. Twelve of the instructional materials units were built around two selections; in seven of these twelve cases only one of the selections contained science content while both selections were considered scientific in nature in five cases. Examination instructional guidance showed that directions for individual selections in dual selection units could not be clearly distinguished. Thus all instructional guidance in a set containing at least one science selection was considered in the analysis.

Procedure for Identifying Types of Instructional Guidance

Each instructional set contained diverse suggestions. To capture the diversity, we began by sampling instructional sets from each publisher at each grade level, first from the entire inventory (980 sets) and then focusing more specifically on those 233 instructional sets corresponding to the science selections. As each set was examined, we progressively developed lists of instruction types encountered and exemplars of each type. Regular meetings were held in which we compared notes and worked toward the development of a common system of classification. The final coding system evolved from this iterative process that included pilot reliability tests at various stages and modifications of the scheme with additional rounds of sample coding and discussion. When all team members were in agreement on the coding schemes and high levels of inter-rater reliability were demonstrated, the 233 instructional sets corresponding to the science selections were assigned to two trained coders by alternating sets sequentially (i.e., Coder 1 was assigned cases 1, 3, 5, and so on, whereas Coder 2 was responsible for even-numbered cases). This procedure ensured that each coder was assigned the same number of sets from each grade and publisher.

Reliability of Instructional Coding

After all 233 instructional sets had been coded, a random sample of 10% of sets in each grade by publisher was selected. Each case was assigned to the coder who had not previously coded the set. The two codings of each of the cases in this reliability sample were then compared. Percentage agreement was calculated for each instruction type across all cases. For example, "making predictions" is a type of pre-reading instruction for which coding options included: (1) set did not contain this type of instruction, (2) set contained an instance of this instruction, or (3) set contained more than one instance of this instruction. Coders agreed 96% of the time on the coding given to "making predictions." Although this three-option choice (no, yes, multiple) for instruction type was a common coding pattern, other patterns reflecting sub-types also existed. In all, 96 instructional types were coded yielding a range of agreements from 67% to 100%. The lowest agreement was on "phonics instruction." Investigation revealed that coders were sometimes unclear as to whether sound-letter instruction was about phonics, about spelling, or both. On the whole, however, percentage agreements were very high with an overall average of 92% for the subset of instructional directions most clearly associated with reading.

RESULTS

Nature and Quantity of Selections with Science Content

Table 2 shows the number and proportion of "yes" plus "maybe" selections by grade and publisher. Overall, about one fourth of all selections, 238 out of 1106, contained some science content. The second grade had the least amount of science across all publishers, but the pattern of fewest and greatest number of science texts varied considerably from publisher to publisher. Overall,

Table 2. Number and Proportion of Selections with Science Content by Grade and Publisher

Grade	Publisher			
	Gage	Ginn	Nelson	Totals
1	21 /.33	9 / .18	7 / .15	37 / .23
2	9 / .16	6 / .12	11 / .21	25 / .16
3	12 / .24	17 / .24	12 / .26	41 / .24
4	10 / .15	15 / .17	16 / .30	41 / .20
5	9 / .15	16 / .19	17 / .26	42 / .20
6	12 / .20	17 / .20	22 / .39	51 / .25
Total	73 / .20	80 / .19	85 / .26	238 / .22

Nelson contained the most science, which generally increased by grade. This pattern of increa science by grade did not hold for the other publishers.

We investigated the 238 selections that contained scientific content from a variety perspectives. Genre was determined by the coding that had been assigned to these selections previous investigation into the text types included in these three commercial reading programs Phillips et al., 2005, for definitions of various text types). Expository texts dominated, accoun for just over half of all science content selections (128 or 54%). This pattern held for all grade that expository texts made up the greatest number of science texts at each grade (49% to 68 Hybrids were the second highest, accounting for 29 or 12% of science selections, whereas selections (10.5%) were narratives. All other text types were relatively infrequent: multiple t (8%), poems (7%), "other" (6%), autobiography/biography (2%), patterned texts (1%), plays (C There were no obvious patterns in the text types by grade other than that patterned texts were fo exclusively at grade 1, and auto/biographical texts only appeared in the grades 4 to 6 selections

Type of science content was determined by identifying the primary science focus of e selection as one of the following: Life Science (animal characteristics and behaviors, plants, biol etc.), Physical Science (chemistry, physics, energy, light, sound waves, electricity, etc.), E and Space Science (solar system, archeology, geology, earthquakes, weather, etc.), Understanc Technology, or "Other," which included understanding science in general as well as science f personal and social perspectives. Of these, Life Science clearly dominated, as it was the focus of 4 of all selections. In descending order, the other science domains represented were Understanc Technology (23%), Other (20%), Earth and Space Science (12%), and Physical Science (4%).

Nature and Quantity of Guidance for Reading Instruction

The process of identifying types of instructional guidance yielded a list of 96 that we grou into 19 categories. These included directions related to all aspects of literacy including reac instruction, writing instruction and assignments, assessment, extending the text through additic information, project work, modifying instruction for various needs, making links to the home, integrating instruction with other curricular areas.

We identified the instructional guidance most clearly associated with the reading proces the 238 selections that contained scientific content. Table 3 displays these 50 types of instructioı

Table 3. Types of Instructional Guidance and Percentages of Instructional Sets Containing Each Type

Number	Type of Instructional Guidance	% Instructional Sets
	Pre-Reading Instruction	
1	Activating prior knowledge through making predictions	44
2	Activating prior knowledge through personal connections, examples and experiences	96**
3	Activating prior knowledge through other exercises	8
4	Building personal knowledge prior to reading the selection	58*
	Mid-Reading Instruction (during reading activities/directions)	
5	Listen and read along	40
6	Choral reading	8
7	Ask/answer questions during reading	29
8	Students make and confirm predictions throughout reading	11
9	Reflect/discuss during reading	51*
10	Re-read/re-visit text	40
11	Note taking while reading	32
12	Read only – no instruction or direction during reading	27
13	Read and perform the selection	11
14	Other supported reading of text not listed in 5-13 above	16
	After Reading – Understanding the Text	
15	Checking predictions/pre-reading	49
16	Answer factual questions (answers in text – information location)	19
17	Apply information to or from the selection	16
18	Explain concepts from selection in own words	54*
19	Infer information not explicitly stated in the selection	36
20	Interpret information from diagrams, pictures, charts, poetry, etc.	11
21	Summarize, re-tell, give information from selection	25
22	"Other" comprehension of text	10
	After Reading – Understanding the Text – Personal Response	
23	Personal response – thinking/inferring	52*
24	Personal response - reflecting	75**
	Language Instruction	
25	Using context to identify words	20
26	Conventions (sentence structure, punctuation, capitalization, other)	17
27	Parts of speech	17
28	Phonics	34
29	Spelling	38
30	Vocabulary expansion/usage	36

Table continued on next page.

Table 3. Continued

Number	Type of Instructional Guidance	% Instructional Sets
31	New vocabulary	75**
32	Language reinforcement	49
33	Other language instruction	6
	Oral Language Instruction/Activities	
34	Express opinion	6
35	Discussion	94**
36	Drama/role play/narrated reading	18
37	Oral language instruction	28
38	Listening	21
39	Presentations	37
40	Other uses of oral language	8
	Reading Instruction – How to Improve Reading Skills	
41	Reading genre instruction	48
42	Reading text features	51*
43	Reading reinforcement	20
44	Other reading instruction activities	14
	Research	
45	Information gathering	69**
46	Experiment	5
47	Organizing research information	30
48	Research instruction	25
49	Other research	2
	Visualizing/Imaging – mentally picturing a scene, character, etc.	
50	Visualization	22

* > 50% & < 75% of instructional sets contain the instruction type

** ≥ 75% of instructional sets contain the instruction type

nine categories that roughly characterize the placement (e.g., pre-reading) or nature (oral language instruction/activity) of the instructional guidance and provides the frequency of each instruction type across grades and publishers. Single and multiple instances of an instructional type are given the same weight within instructional sets. For example, in the case of the first type, "Activating prior knowledge through making predictions," there were 100 instructional sets (43%) that contained a single instance of this type of guidance. Two instructional sets (1%) contained more than one such instruction. Thus, the overall reported frequency of 44% is to be interpreted as *the percentage of instructional sets that contain at least one instance* of a pre-reading instruction that asked students to make predictions.

Although it is difficult to characterize the reading instruction that accompanied the science text selections from the list of instructional types and overall frequencies, several findings bear mentioning. A first observation is that, although many different types of instructional suggestions were enumerated, the majority of tabulated frequencies was considerably less than 50%. Thus, all instructional types are clearly not included with each selection. Rather, each selection is accompanied by some combination of directions, no doubt for various purposes.

Considering within-category patterns, most categories contain "other" options (listed last within each of the nine categories). In these cases, the frequencies are usually low, indicating that the listed types of instruction for that category capture most of the types of instructional guidance. For example, in the Pre-Reading Instruction category, four instruction types including "other" are listed. Three of these involve activating prior knowledge and one attempts to build personal knowledge prior to reading the selection. The frequencies show that publishers appear to have gotten the message that activating or building knowledge prior to reading is extremely important as almost all selections have one or more of these types of pre-reading instructions. Of these, asking children for personal connections, examples, and experiences is clearly the most popular pre-reading direction (the reported frequency of 96% consists of 68% of sets that have one instance of this instruction type and 28% that have more than one instance). Frequency of "other" types of pre-reading instruction is low (8%), suggesting the given types account for most instances of this type of instruction.

Most of the frequently occurring instructional types (frequencies greater than 50%) are those that involve personal reflection or response. In our data, these are often cross-classified with the most frequent oral language activity, which is discussion. For example, Table 4 lists some questioning suggestions that involve personal reflection/response. These questions differ in a number of respects. Some are intended for pre-reading, others for mid- or after-reading. They differ in foci or intent: included in these are probes for personal experiences, personal preferences, personal learnings, and personal ideas or thought processes. They therefore do not necessarily come from the same categories in our coding system but they all share some element of personal connection to the learner.

Discussion was by far the most frequently suggested activity. Masked in the reported frequency of 94% (see Table 3, suggestion #35) are the percentages of sets that had multiple suggestions for discussion. A more detailed data breakdown by grade revealed a range of 64 to 96% of sets having multiple calls for discussion. That is, at all grades, the majority of teaching units contained multiple suggestions for discussion. Discussion is suggested for a variety of purposes in these sets, often as a means of getting children to consider questions that involve some sort of personal reflection/response as in the following pre-reading instruction [with our codes in brackets]:

> In small groups, discuss [DISCUSSION] *your* experiences with magnets or compasses. What can magnets be used for? Have you ever used a compass to find your direction in an unfamiliar place? [ACTIVATE PRIOR KNOWLEDGE through personal connections/experiences] (Cornerstones, Gabe 3b, Teachers' Guide, p. 182)

The fact that personal response/reflection and discussion are so prevalent in the instructional guidance associated with science selections looks, at least superficially, to be quite promising for fostering scientific literacy. After all, the importance of making connections to students' perso knowledge and making subject matter personally relevant to students is by now widely acknowled in the literacy field (Dillon & Hoffman, 2002). Discussion is a well-known instructional tool w several variations including using it as a means of instruction, as a teacher-directed conversati and as a means to generate thought and new ideas. However, to what extent does discussion tl does occur draw on the fundamental scientific concepts that are in the texts and support readi as inquiry? The answer is unknown at this time but it is important to an assessment of the valu these programs in supporting scientific literacy.

We looked at the frequency of occurrence of each instructional type at each grade and tl classified the results according to whether there was no discernible grade trend or whether th was either a tendency or a clear trend for the instructional type to be found either at the lowe higher grades. About half of all reading guidance types showed no clear grade patterns. Frequen jumped or dropped from one grade to the next in ways that could only be interpreted to mean tl grade played little or no role in the inclusion of the instruction type. However, frequencies w high at all grade levels in three areas: (a) activating prior knowledge by asking students to m personal connections, (b) identification of new vocabulary words to be taught, and (c) suggesti for student discussion. Instructional types with multiple sub-types are complex to describe grade. For example, the frequency data showed that 69% of instructional sets contained at least instance of "Information Gathering" (see Table 3, #45). These data, however, included eight s types of information gathering. When these were combined, the data indicate that this activity high at all grades. Sub-type examination, however, reveals some grade differences. Making/recordi observations, for example, was a generally more frequent instructional activity in the lower gra whereas information gathering via interview appeared only in grades 5 and 6.

Trends of higher frequencies of instructional types at the lower grades were more preval than trends of higher frequencies at the higher grades. Of the reading-related instructional ty 30% (15) showed frequencies that were higher in the lower grades. For example, "Choral Readi (see Table 3, #6), showed the highest frequency of occurrence at grade 1 (32%) and grade 2 (12 then dropped from 5% to 0% for the remaining grades. Similarly, "Listen and Read Alo instructions (see Table 3, #5) occurred more frequently in grades 1 to 3 (percentages of 57, 44, respectively) compared to grades 4 to 6 (percentages of 29, 36, 33). "Phonics" (see Table 3, #. and "Reading Text Features" (see Table 3, #42) were instructional types that also showed quite cl trends of decreasing frequencies by grade. Most text feature instruction had to do with illustratio photos versus features such as charts, captions, sidebars, and overall organization, and this is lik reflected in the fact that about 72% of instructional sets contain "text feature" instruction at gr 2, whereas only 33% of grade 6 units do so.

Very few instructional types showed a tendency to be more frequent at the higher grades. T activities that showed such a tendency were asking children to explain concepts from the selection their own words (see Table 3, #18) and asking them to infer information not explicitly stated in selection (see Table 3, #19). In these cases, there were fewer instances of the instruction type at gra 1 and 2, a peak at grade 3, and a leveling out to higher frequencies for grades 4 to 6. The clea grade trends of increasing frequency were found for the personal response questions (see Table 3 23 and #24), which call for thinking/inferring and reflecting. Although the overall data indica

Table 4. Questioning Directions/Suggestions that involve Personal Reflection or Response

Invite the children to think of a few questions *they would like* answered about ants or earthworms.
Will this report change the way *you* use water? Why?
Why do *you* think astronomers study the stars?
What did *you* learn about water that surprised you?
Have *you* ever wished ...? What did *you* find the most interesting about ...?
Did *you* like the story? Why? Why not?
How have *your* ideas about ... changed since discussing the picture?
Did *you* find some of the information hard to understand? ... what? ... why?

that about half of the instructional sets (52%) included at least one instance of questioning calling for personal thinking/inferring (see Table 3, #23), the grade data clearly showed that directions for teachers to ask these types of questions were much more frequent in the upper elementary grades. At grade 1, only 24% of instructional sets included such a question whereas 63% of sets included this question type at grade 6. Additionally, the percentage of sets having multiple questions was highest in grades 4 to 6. Thus, this type of questioning, which seems to have clear relevance for the development of scientific literacy, is most frequently encountered in directions only for upper elementary reading instruction. Personal reflecting questions (see Table 3, #24) were considerably more prevalent than thinking/inferring personal responses (see Table 3, #23) but showed a similar, if somewhat weaker, grade trend. At grade 1, 49% of instructional sets contained at least one such question and the data showed a steady increase up to 91% by grade 5. A frequency drop at grade 6 (75%) may be related to the continued increase of more inferring/critical thinking questions.

DISCUSSION

This study was motivated by an interest in the potential of commercial reading programs for fostering the fundamental sense of scientific literacy, that is, the ability to read and write when text content is science related. The identification of science texts and the quantification of types of literacy instruction associated with science content selections were basic to this inquiry. Our analysis, however, does not lead directly to a conclusion on the potential usefulness of the texts and instruction. For insight, we looked qualitatively at how texts and instructional suggestions did or did not work together towards the specified end. In particular, we considered whether the opportunities presented by text were optimized in the instructional suggestions and the extent to which the instruction supported reading as inquiry (analyzing, critiquing, and interpreting text). We offer some observations concerning this text-instruction interface.

The instructional guidance included a wide variety of well-recognized reading strategies, but the usefulness of these strategies for fostering scientific literacy is tied to the quantity and quality of scientific content in the selections. To begin, the science texts focused primarily on Life Science topics thereby raising concerns about whether children's perceptions of science are affected by such a predominant focus. Genre was also implicated as we found fewer literary texts (narratives, poems) with scientific content and, in general, there was less scientific content found in narratives and poems than in the expository texts that contained scientific content. When these text characteristics are considered in light of the many frequently occurring reading directions that involve discussion and personal response, our findings suggest a gradient of usefulness.

Less useful for the purpose of fostering scientific literacy are discussions and personal responses that do not draw on the fundamental science concepts in the texts but rather focus on personal feelings, opinions, and preferences, or literary characteristics of the text such as elements of a story (events, characters) or poem (images, feelings evoked). These include examples such as the following that we readily admit may be good discussion questions for some purposes but do not seem optimal as a science focus: (a) What do you think will happen next? (discussion of events in a story); (b) How did you feel … discuss images and feelings the author created…?; (c) What did you like about …?; (d) What are your favourite insects? Do you dislike any insects? Why?; and (e) What did you think of this article? What was the most interesting thing you found out?

Our probing further suggests that the instruction that was generally associated with the narratives and poems with scientific content tended not to focus on the science content but rather on literary techniques and personal responses involving preferences and opinions, emphases that do not make optimal use of the scientific concepts that were in these texts. Genre alone, however, is not a determinant of the usefulness of the text for fostering scientific literacy. We identified poems and narratives containing a good deal of scientific content with useful accompanying instruction. Occasionally, we also found the same selection used by different publishers in quite different ways. *Ladybug Garden* by Celia Godkin (1995), for example, is a narrative used in grades 3 and 4 that we rated high in scientific content. One publisher (Gage, grade 3) provided instructional guidance that focused more on the scientific concepts in the text and seemed conducive to teaching reading as inquiry, whereas another publisher (Nelson, grade 4) used the selection to focus more-or-less on fact finding ("What three interesting facts did you learn from the story?") and included personal response suggestions that do not require students to engage much in inquiry ("Which illustration especially appeals to you? Why?").

At the higher end of the usefulness gradient for fostering scientific literacy were texts that contained a high percentage of scientific content and accompanying instructional suggestions that (a) related to the fundamental scientific concepts in the text and asked students to analyze, critique or interpret; or (b) helped students become more aware of language that reveals scientific reasoning (e.g., *observe, compare, experiment, evidence, research*). The more useful types of questions and discussion suggestions tended to accompany expository texts that contained considerable science content. However, we identified cases illustrating little relationship between the quality of the text and the quality of the instructional guidance for the purpose of fostering scientific literacy. *Dancing Bees* (modified from *The Big Bug Book*) by Margery Facklam (1994), for example, is an expository text used in grade 4 that we considered to have excellent potential for teaching reading in science. The text contains some fundamental scientific concepts regarding bee communication about food sources and gives an example of an experiment that illustrates the work of scientists and the concept of observing, posing questions, and devising ways to find answers to these questions. The selection could have been used to teach students to read science text through interpreting scientific questions that seek explanations, interpreting descriptions of research methods and experimental tests, and distinguishing evidence from conclusions. The potential of the text, however, was unfortunately not fully realized in the accompanying instructional guidance that included personal response suggestions for students to share interpretations of dance, develop their own dances, and imitate the bees' waggle dances along with a discussion about ways robots are used to help people generally (the selection features a robot bee that was used to gain information about bee communication). Although a variety of seemingly useful reading strategies appear in the teachers' guide, the focus of the instruction is not consistent with the fundamental science concepts in the text. Unless high quality texts are accompanied by instructional guidance that optimizes the scientific content, the potential for fostering scientific literacy is significantly diminished, if not lost completely.

CONCLUSIONS AND IMPLICATIONS

This investigation established that these widely used commercial reading programs do contain science content; approximately one fourth of all selections contained science content, although the quantity and quality of the science varied. The reading instruction that accompanied the science selections consisted of a wide variety of strategies and activities, some of which were more frequent at earlier grades and few of which increased in frequency with grade. There was a preponderance of personal response and discussion suggestions, an emphasis that appeared initially promising for fostering scientific literacy but that seemed less consistently useful when the text-instruction interface was examined. There were numerous instances of instructions to engage in discussions but few that engaged the text in a critical manner, a finding also identified by Palincsar and Magnusson (2001). Although the texts and instructional guidance in these widely used commercial reading programs showed some potential for fostering scientific literacy in its fundamental sense, we believe that this potential is unlikely to be fully realized and that the limitations of these programs do not allow for a fruitful integration of science and literacy.

One reason the potential of the selections was unlikely to be realized is that such potential may not be recognized. In general, teachers are not provided with reliable direction on scientific content in selections and there was little clear guidance for using the selections for the purposes of teaching scientific literacy. It is quite likely that the program authors assumed that other science texts would be used to teach scientific concepts and that the inclusion of texts with science content in these series was primarily to provide opportunities to encounter important text structures and to allow for curricular links. Thus, publishers may have intentionally included more informational texts with a variety of content, some of which is science, but the scientific concepts and any associated metalanguage were not necessarily the object of instruction with the selections that had science content. Multiple purposes were reflected in the wealth of instructional guidance that accompanied each selection, and, even if useful guidance was provided, the probability that a teacher would focus on the best instructional suggestions was not great without a conscious effort to determine how the text could be useful for science reading. Thus, perhaps not surprisingly, the teacher seemed key to making use of the limited potential of the programs. Optimizing the potential would require a teacher who is knowledgeable about both science and reading and who further has a conscious intent of making use of these texts for specific purposes associated with fundamental scientific literacy.

Even if all text-instruction interfaces were optimal and optimally recognized and utilized by the teacher, we conclude that use of these programs alone is unlikely to foster a truly effective connection between science and literacy. The reasons for this have to do with limitations inherent in programs that focus on teaching literacy skills and strategies apart from a sustained and depth exploration of content (Walsh, 2003). In a collection of unrelated selections includ a variety of purposes, it is simply not possible to provide students with sufficient materia allows for sustained development of domain knowledge. Thus, although text plays an impo role in inquiry-based science (Cervetti, Pearson, Bravo, & Barber, 2005; Saul, 2004), the con provided by these programs do little to support the growth of rich conceptual networks tha result from spending time with related texts over an extended period of time. Approaches to rea instruction that have focused on building cumulative knowledge in a coherent knowledge do over time (e.g., Guthrie et al., 1998, 1999; Romance & Vitale, 1992, 2001) have shown mea advantages over traditional use of basal readers for literacy instruction in terms of scienc comprehension, conceptual learning, and reading engagement.

In these approaches, meaningful learning in science is linked with reading comprehen through hands-on activities and literacy activities that help students identify core concept concept relationships to build cumulative domain knowledge. In contrast, fragmented concep knowledge is likely to result from the hit-and-miss approach to science content that is found the commercial reading programs we investigated. Further, the relationship between firsth experience in inquiry-based science learning and the science learning that occurs through the of text is far from ideal. It is difficult to convey to students authentic uses of reading (and ot literacy abilities) in science if the science is supplanted by literacy instruction for its own sa Thus, at best, these programs can play a limited role in fostering scientific literacy, and elemen teachers are cautioned against over-reliance on these programs for developing the relation between science and literacy. Furthermore, science educators ought not to be seduced into think that because science is an integral part of reading programs that the fundamental sense of scien literacy (reading and writing when the content is science) will be taught better than in a stand-alo science program, although we believe the risk of such seduction is high in programs that con a considerable proportion of science text and use this fact as a selling feature. New collaboratio between the science education community and literacy researchers are needed, and we hope th recent endeavors in this regard will lead to more effective instructional materials and approaches to fostering scientific literacy.

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