

WHAT WORKS? Research into Practice

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Research Monograph #26

How can science and literacy teaching in the elementary classroom be made mutually beneficial?

Research Tells Us

- Language use in the learning of science aids students' development of literacy and associated cognitive skills.
- Science can be learned most naturally and effectively in collaborative, social contexts.
- Science-specific literacy work, such as discourse and the keeping of science journals, promotes scientific learning.

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Science and Literacy in the Elementary Classroom

By Dr. Paul Elliott, School of Education and Professional Learning, Trent University

Language, both spoken and written, is central to exploring scientific phenomena, sharing and testing ideas and demonstrating understanding. Additionally, language use in the learning of science aids students' development of literacy and associated cognitive skills. So, how can we embed the acquisition of literacy skills in science and promote synergy between the teaching of science and literacy?

Science can be learned most naturally and effectively in collaborative, social contexts.³ This can be fostered through the use of literacy strategies that help children draw on real-world evidence to generate explanations, arguments and questions. From the earliest grades, students can be supported to develop positive habits and attitudes towards learning science (including collaborative approaches)⁴ and familiarity with and competence in the use of the language of science.^{2,5} Science-specific literacy work, such as discourse and the keeping of science journals, has been shown to promote students' scientific learning.^{1,6} It also benefits students who are still acquiring English language skills, by enhancing their literacy as they learn about science and scientific inquiry.⁷

Students enjoy demonstrating their comprehension of ideas by learning to use scientific terminology correctly. To help them in this, teachers can employ a range of strategies, some of which are intimately connected to the development of literacy as part of science. Literacy skills are needed both to learn science effectively and to practise science. Students studying Grades 1 through 6 of the Ontario curriculum encounter more than 170 scientific words and need opportunities to incorporate these into their vocabulary. Yet, literacy in science is about more than just the development of familiarity with scientific vocabulary and writing genres: it is also about the use of language in inquiry and the construction of meaning. 6,8

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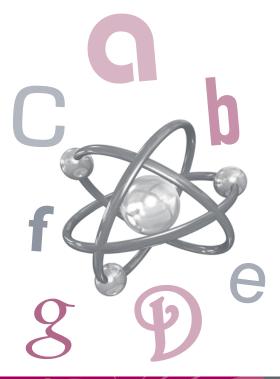
In classroom practice ...

Vocabulary

- Explore new scientific vocabulary wherever it is encountered.
- Help children to take ownership of vocabulary by listening, speaking, and exploring the structure of words, and by using them in writing.
- Create a science word wall.
- Help children create their own science glossaries and employ scientific journal writing.

Talking and listening

- Facilitate peer-to-peer talking and listening with techniques such as think-pair-share and jigsaw.
- While working on an inquiry or problem-solving activity, have "home groups" send an envoy to other groups where they exchange and probe each other's ideas.
 Envoys return home and report – a great way for groups to test and refine their ideas.
- Use student talk as a forum for formulating questions that may be answered through inquiry.



Teaching the Language of Science

Science as a foreign language

Much of the language of the science curriculum is, initially, new to students. It includes terms that they are unlikely to have encountered (e.g., *pistil*, *electrostatic*) and words with scientific meanings different from everyday usage (e.g., *competition*, *matter*). When teaching science, we should see ourselves as teachers of a foreign language, introducing new and unfamiliar vocabulary.³

Many polysyllabic scientific words have origins in Greek (e.g., hypothesis) and Latin (e.g., habitat). They differ from most words in the vocabulary of children whose first language is English; vocabulary acquired early mostly comprises shorter words with Anglo-Saxon or Nordic origin (e.g., wood, pig). Teachers and children can explore the morphemic structure of more complex, polysyllabic science words to give meaning to some of the roots, suffixes and prefixes used in scientific terms (such as those in Figure 1).

Figure 1

Roots, suffixes and prefixes	Meaning	Roots, suffixes and prefixes	Meaning
-able -arthr -ate	capable of joined the act of (verb)	-ity -lepsy mamm-	property seizure breast
atmo-	vapour	meta-	between
bio-	life, living	-meter	measurement
carn-	meat, flesh	micro-	small
-cide	destroy, kill	-morph-	shape, form
-cycle, cycl- de- epi- -er -fract-	ring, circle away from, down above one who break	-oid -phone, phon- -pod prim- re-	appearance, form sound foot first again
hibern	winter	-scope	device for seeing
herb-	plants	spec-	look at
-hydr- ign- inter- -ism -itis	water fire between process or condition inflammation	sub- tele- -therm- -(a)tion trans-	under, below far off, distant heat the act of (noun) across

The meaning of roots, suffixes and prefixes found in the elementary science curriculum

Science as someone else's language

Scientific terminology used in the home by adults and peers can reinforce, or even be, the source of children's deep-seated preconceptions: *Force*, *energy* and *theory* are commonly used in ways that cause confusion when children are introduced to them in a scientific context. Students are reluctant to discard such preconceptions in favour of new models of understanding. Teachers need to be alert to students' preconceptions and use them to promote conversations, generate questions and journal entries, and invite testable predictions.

Literacy strategies offer valuable diagnostic opportunities to bring preconceptions to light; for example, children writing about the living things that they might find in a local forest may include *animals* but also *insects* and *birds*, thereby revealing that they do not think of insects and birds as animals. Such constructivist approaches to learning are typified by group activities that include talking,

listening, and the use of collaborative written output. When children use scientific language in these ways and self-test understanding, they start to take ownership of the scientific phenomena that the words represent.⁶

Implications for Classroom Practice

Take time over science words

New vocabulary should be identified as such and carefully explored. Children need the chance to say words aloud before learning spelling. Where appropriate, the morphemic structure and meaning of roots and stems should be explored (see Figure 1).

Word walls

Word walls publicly share and record new vocabulary. Children can be encouraged to contribute and to use them as a source of ideas and a place to check spelling. Older children can add their own definitions to a glossary at the back of their science notebook as they encounter new terms. Words they record can be revisited, allowing definitions to be revised over time as understanding develops.

Talking about science

Student discourse is central to the development of literacy; it facilitates the exploration of unfamiliar ideas and concepts and enables the construction of understanding. Many teachers already structure opportunities for children to talk and listen to each other, using tried and tested techniques such as "think-pair-share," "jigsaw" and "envoys." These collaborative approaches reinforce the message that science is essentially a social endeavour.⁴

Reading about science

Reading is a simple way of introducing science topics, but the choice of material is crucial. Texts that use correct scientific terms provide opportunities to discuss new vocabulary, for which students can subsequently take ownership. This is a powerful learning opportunity because so many scientific ideas are intimately associated with specific vocabulary. There is evidence that integrating structured reading opportunities into science classes can significantly enhance teaching and learning. ¹⁰ Pre-reading strategies (e.g. looking at images and headings first, discussing prior knowledge and identifying the purpose of the reading) support reading and maximize the resulting benefits. ¹ Independent readers can be shown how to use strategies such as text-marking to help them analyze text.

Writing about science

Science writing can take many forms, including journals, diaries, graphic organizers, calligrams (visual representations of words that reflect their meaning), poems and other creative writing.³ The use of journals is an effective way for children to explore their understanding, in drawings as well as writing, and to practise the use of newly acquired vocabulary. It also encourages the generation of questions, which can then be used in inquiry.⁶ Some children find inquiry-based science provides the motivation to write. When writing is used as a culminating activity it needs to be made purposeful.³ The following are some helpful tips to get students writing for their intended audience:

- Think about the audience and what the writing is to achieve. There are many possible audiences: a friend who missed the class, younger children in other grades, a scientist, an adult at home or a school principal.
- Ensure that there are sources of inspiration. Motivation for writing can stem from visual learning, so employ engaging demonstrations, films and photographs. Ideas can also be generated through practical work and the use of drawings, graphic organizers, lists, tables and Venn diagrams. Ask children to visualize or draw their ideas and discuss them with a partner before they start writing.

In classroom practice ...

Reading about science

- Provide opportunities for reading texts that use age-appropriate scientific vocabulary.
- Use pre-reading strategies such as looking at images and headings first, and discussing prior knowledge and the purpose of the reading.
- Explore texts together: Identify and discuss new vocabulary, and use metacognitive strategies such as text-marking (e.g., highlighting, circling key words, numbering ideas) to help students identify new ideas.
- Help children generate questions to which they could seek answers through practical inquiry.
- Summarize ideas.

Writing about science

- Give opportunities for talk about science before students write.
- Promote emerging understanding through the use of scientific journals.
- Use group work and collaborative writing opportunities, such as the production of concept maps, to give children the space in which to construct understanding.
- Encourage children to consult word walls, dictionaries and their own glossaries when writing.
- Show how to write about science for different audiences and discuss the conventions of the genre being used. Share good examples.

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- Share examples of the type of writing needed. Children do a better job if they have a clear idea of what is expected of them. Frames with prompts or sentence stems can help support early attempts to structure writing. The writer completes the sentences and may then use them as the core around which to develop informative writing.
- *Encourage critical reflection.* Give children opportunities to read through their work, compare it with their peers' work, share good examples, and develop and revise their ideas.
- Encourage collaboration. Carefully planned pair and small group work allows children to engage in oral drafting, as they share and justify ideas, modify thinking, confirm the validity of ideas and, together, improve and refine their ideas. There is evidence that the opportunity for peer-to-peer talk before writing greatly enhances the quality of the writing produced and the retention of the knowledge acquired.⁸
- Provide access to reference materials, word walls, dictionaries, etc. The act of writing may prompt children to validate information or seek further detail, so reference sources should be available. Vocabulary can be extended and consolidated when access is given to word walls, thesauri and dictionaries.

In Sum ...

Meeting all the demands of the elementary curriculum is challenging, and literacy is a key area of focus. Placing an emphasis on literacy can be compatible with developing children's scientific skills and understanding. Planning such opportunities need not be difficult and can easily be incorporated into routine practice. Science provides an effective context for nurturing literacy skills. By using science as a vehicle for promoting literacy, teachers enhance their students' experiences in science.

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