SCIENCE LITERACY: HOW TO TEACH?

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Abstract

On primary level children get very little opportunity for training in reading explicatory and informational texts. However, such kind of texts predominate the school and private life of older children and adults. The use of informational text in content area reading is of course commonplace in science education once children have passed the learning-to-read stage and are fully reading to learn. Primary level should prepare them for learning from explicatory text and for searching information as well. In this article the way, how to begin to develop science literacy skills shall be explained. Such science literacy in the framework of which, students on primary level should learn how to learn science from explicatory texts and how to find information in explicatory and informational texts to solve the tasks they are confronted with in their science class.
Key words*: science literacy, learning from explicatory text, information literacy, finding information -reader's strategies, impact on education on primary level.*

Introduction

Last two decades of 20. Century confronted the school field researchers of many countries with very unpleasant fact: the students in their school system do not achieve a sufficient level of literacy in comparison with the students of countries with comparable good developed school system. It happened also in Slovenia - although no problems with literacy seemed to exist. By that times everybody compared the literacy level of Slovene inhabitants with the literacy level of population in south Yugoslavia (Kosovo, south Serbia), where basic iliteracy was still the problem. And everybody was satisfied with situation at home.

But new - international assessment of literacy didn't ask only for basic literacy. It demanded more: it demanded functional literacy - literacy which could be used to survive and be successful in the new civilization at the end of millennium. Of course everybody agrees that being successful in PISA and PIRLS is not the aim of the school system but the fact that those assessment checks the literacy, needed in life and in current school system, can not be denied.

So we must ask ourselves the question: what was wrong and what can be done? The answer to the first question is obvious:

- it is not enough to teach (and practice) reading only in the first half of primary level,

- after decoding skills reading comprehension must be taught,
- it is not enough to develop only comprehension of narrative texts (stories and poems),
- reading for learning science texts must be taught and practiced,
- reading for searching information must be taught and practiced separate and
- not only reading words, also reading pictures and graphics must be taught.

All this changed the (reading) curricula on the secondary level in most European countries and America (and that is the reason, why the results in PISA and PIRLS assessment are getting better - also in Slovenia) but we must admit that on primary level we could achieve more as we did. Because reading on primary level is still

- to much traditional,
- to much focused only on pure practicing reading skill and
- using too much narratives (poems, tales) for that process.

This article describes the changes that should happen in primary reading curricula to prepare students for informational - explicatory reading in natural science class on secondary level.

Teaching of reading comprehension - the crisis of science education

Reading comprehension is a multifaceted process. In addition to decoding skills, students need vocabulary knowledge and metacognitive skills so they can monitor their understanding and reflect on what has been read. Some teachers may assume that reading comprehension will develop naturally without any direct teaching of comprehension (Denton, Fletcher, 2003). Many researchers believe that given enough exposure to variety of texts the child would become good reader and learner from any text. Nevertheless, research has proven this conclusion is wrong. Each **reading skill must be taught through formal education**. Learning to decode is a not enough. It must lead to understanding written communication created by others. In other words, reading lessons do not end, when students can decode the words. They continue with the instruction that will support their understanding of what readers are reading about.

And what are the texts, students need to read?

In their (school) life students are confronted with much kind of texts, which are read with different motivation. Of course they, like previous generations, still read literary texts (fairy tales, novels, poems) but mostly they read science texts for learning and information. In this situation the fact that elementary school children are not often enough reading science texts can not be neglected any more, than **the problem with children's science learning** can be attributed to a lack of instructional emphasis on science in the early grades and to elementary teachers'. Or in other words: we must start **developing science literacy on the primary level** - because we can not start early enough.

Reading for learning from science texts - science literacy

Science literacy incorporates an understanding of the nature of science, investigations of the natural world, the ability to use reading, writing, listening, and speaking to learn about science, interpretation of data, and communication of scientific findings, features prominently. The science literacy curricula students train to use reading and (listening) strategies to get knowledge about science topics and to get the information from the field of science. (Yerrick, Ross, 2008) The **science reading curricula** teach

- reading expository texts,
- acquire knowledge (learn) from expository text and teach,
- how to get a single information or set of information from the same kind of text. (Yetton, Alexander, 2008)

Reading expository text and learning from them - how to teach

When we read a text, above all when we read an expository text, we have to recall a previous knowledge. There is no chance that we understand, what we read - without previous knowledge. Knowledge is the prerequisite for our understanding. Knowledge is, of course, complex, with many forms and dimensions (Alexander, Schallert, Hare, 1991).

- Readers use linguistic knowledge to decode the language,
- Readers use knowledge about in the text "described" topics, which can be derived from previous reading situations or from the real (first hand) life experience,
- Readers use knowledge of text structures, which allows readers to access information more readily and accurately as they construct their personal interpretations of the text.

Expanding Students' Experiences and Vocabulary

Traditionally we think that above all literary reading widens person's (child's) vocabulary. But a careful thinking brings us to the conclusion that learning about the nature and the world is accompanied with the process of naming new things and new facts. In other words: when the child sees the new type of dog he can learn the word for designating it: *"This is a golden retriever!"* This fact must have the consequences on our teaching on primary level, since many explicatory (science) texts include vocabulary, which is different from the everyday vocabulary the child is used to.

So the first step in preparing children for reading an explicatory text should be to improve his linguistic knowledge, to widen his vocabulary on in the text described topic.

Of course we can use a classical presentation or classical talk for conquering new vocabulary. Or we can use a mind map. But if possible we should use an active way for introducing varied contexts and events we are going to read about. For example, we can integrate literacy and science class. We can offer students personal experiences and connections that would allow them to transact with the texts (Rosenblatt, 1995). To achieve this, we can take students on an excursion to a farm, to the lake, into the kitchen, where their school lunch is prepared. There we first talk with them about things; they are new to them (and use new words). After coming home (into the classroom), children can make notes, look at the pictures, we have made together, talk about the amateur film if we filmed some video and talk about collected samples or material we have brought with us. This should be opportunity enough to anchor new words into **the child's active vocabulary** - and so to raise the quality of his understanding of explicatory text.

Recognising text structure - a way of learning from text

Preparing student's vocabulary before reading explicatory text is not all we can do to improve students' experiences with expository text. We can do much more by designing instructional environments that incorporate specific experiences with text structures (Bertelsen, Fischer, 2008).

Explicatory texts have the specific text structure - similar as literature texts. Only it is very traditional to educate students about the structure of sonnet or antique tragedy or classical fairy tale and far les traditional to teach students about the **structure of explicatory texts** in their science textbooks. (Bertelsen, Fischer, 2008)

It is very important to equip children with such experience in explicatory text reading, from which they can derive metacognitive knowledge about the science textbooks text structure. We must and can do it on the primary level!

Why must?

Because very inexperienced readers tend to believe all the words in the text are equal important. This fact is easy to prove: asking children to underline, what is important in the text - they will

underline everything, and asking children to learn a text from the textbook, they will learn the first sentence so long, they will be able to repeat it literately. After that they will repeat the procedure with the second sentence ... and keep repeating it to the very end of the text.

Lessons focused on text structures can help students to find out, what is important and what not! On the primary level we can focus on the following five text structures:

- description,
- sequence,
- cause and effect,
- problem-solution, and
- comparison (McGee, Richgels, 1985; Tompkins, 2001).

Each of the text structure lessons can serve as a teacher-directed mini-lesson. For this aim teacher must prepare the explicatory text for science class, which is clearly structured – for learning recognition of the text structure the later must be easy to recognize as type 1, type 2. Mix structured text in this phase must be avoided. Working in small groups the students should get the instruction to identify the specific text pattern and locate and highlight cue words that would aid them in the identification and comprehension of particular text. On the primary level the learning process can proceed only if it happens on the level of concrete operations, so the meta(re)cognition of the text structure is possible only, if the child can see it (on the concrete level!). To achieve this, we can ask a child to complete a graphic organizer, which makes the text structure visible. A table below identifies the text structures and graphic organizers, we can use for visualization process of particular text structure.

Table 1. Text Structures and suggested Graphic Organizers (Bertelsen, Fischer, 2008).

Text Structure	Graphic Organizer
Cause and Effect	Cause and Effect Flow Chart
Sequence	Listing
Problem Solution	Decision Tree
Description	Webbing
Compare and Contrast	T-Chart
Sequence	Outline

Text structure lessons can be successful only if science and literacy class are woven together within the context of literacy standards and without losing a conceptual, investigative approach to science. A curricular overlap in science and literacy must be found to determine ways in which students can make sense of daily instruction (specifically with regard to misconceptions in science), develop and provide appropriate reading assignments in science, and promote strategies for their writing about science-related concepts. These way students are involved in hands-on science experiences, enhanced reading and writing opportunities, and supplemental instruction. The result is **science understanding** by increasing the variety of students' experiences in science beyond traditional text-based instruction.

Information literacy - teaching students to find information

Not always our attention is needed for a text as whole. Much more often a reader needs a single information from the text. In today's technological world the ability to create, disseminate, and retrieve information quickly is more and more important. In this context we

talk about informational literacy. We can define **information literacy** as **ability to recognize when information is needed and to locate, evaluate, and use effectively needed information** (American Association of School Librarians, 1989). The emphasis today is that **literacy can no longer be considered merely to be able to read and memorize** a base of knowledge; instead, literacy **must entail the ability to acquire and evaluate information that is needed** in any situation.

"Reading" informational Texts

Informational texts are reliable sources of authoritative information, presented as prose or in document format. Informational texts are most commonly thought of as prose texts — that is, textbooks, encyclopedia entries, journal articles, manuals, and so on. Document formats, such as tables, charts, graphs, maps, forms to be filled in, labels, and diagrams, are significant in communicating information efficiently. The importance of searching informational texts for main ideas and details can be seen in the prominent place given to these abilities in two recent international assessment projects: PISA, the Programme for International Student Assessment of reading literacy of 15-year-olds, and PIRLS, the Progress in International Reading Literacy Study of reading literacy of 9-year-olds. (Brown, 2008)

Reading informational texts often involves **reading to locate particular information**. **This is not reading to learn** but looking up or consulting information in a source and then, frequently, recording that information. This is exemplified by such tasks as locating someone's number in a telephone directory or using an encyclopedia or website to find some needed information. **Locating information is strategic, selective reading to locate specific, goal-related information and often involves skimming or scanning** (Brown, 2008). To skim or scan, the reader rapidly locates information that matches search requirements by seeking key elements. Characteristics of the text being read, the search task to be accomplished, and the reader all contribute to accomplishing this type of reading.

Text characteristics - navigational tools

When given a whole textbook in which to locate information to solve problems, adept readers use the **navigational tools** — that is, the glossary, table of contents, index, or review questions — to locate information. Detecting and using the order, organization, or outline of prose text, which is often signaled by the author, enhances the location and extraction of information. Chambliss (1995) reported that the structure of informational texts consists of a generalization and one or more subtopics. The goal in reading such texts, then, is to obtain the main idea or gist. Information problems may also require students to locate details that support or provide evidence for the main ideas. León and Carretero (1995) pointed out the important role titles of texts play in identifying the principal, logical relationship within a text. Lorch and Lorch (1995) showed how headings signal and aid readers in recognizing the organization of a text.

In addition to titles and headings that show the structural organization of information, there is a range of typographic techniques that draw attention to critical information (Harley, 1996; Waller, 1991 These include the use of such features as <u>underlining</u>, CAPITALIZATION, change of font face, **bolding**, *italicization*, **use of colors**, or the use of punctuation marks such as 'single' and "double" quotations. Judicious graphic design of pages, including the positioning of text, text boxes, white space, illustrations, or call-outs, contributes to the ease or difficulty of locating information (Brown, 2008).

Table 2   demonstrates navigational tools involved in the finding information in explicatory text

Navigational tools	
Signaling devices	Headings Subheadings Titles Labels Row and column markers
Typography	Boldface Italics Underlining Font faces Capitalization Quotation marks
Structure	Supportive graphics Sections and subsections Paragraphing Topic sentences Tables of contents Indexes Glossaries

Using navigational tools for searching for information by students on primary level

On primary level children get very little opportunity for training in reading informational texts. However, informational texts predominate the school and private life of older children (Daniels, 2002; Newman, 2002). The use of informational text in content area reading is commonplace in science education once children have passed the learning-to-read stage and are fully reading to learn. Primary level should prepare them for learning from explicatory text and for searching information as well.

By than we really can not say children are not exposed to such texts and situations where informational reading skill would be needed. On the contrary science textbooks for primary level (and science textbooks designed for next levels) use navigational tool (external text characteristics) to point out the important information and to provide help for student's finding information and the tasks used for assessments of acquired knowledge and it's understanding in the textbook demand the information reading skill. Actually even science textbooks for primary level include a variety of types of tasks. To solve them a student must locate information in the text. Such searching tasks vary in their difficulty. Tasks that require location of verbatim declarations are easier than those that require incorporating several elements that are not physically contiguous or explicitly stated in the text (O'Donnell, 1993). Information is easier to find if readers are given the search terms, rather than needing to develop them (Dreher, 1992), single-word search terms are easier than complex or multi-word search terms to use in locating information and answers to text-explicit questions are easier to locate than those for text-implicit questions, which require some inference.

Inexperienced readers on primary level use for such tasks just **skimming and scanning strategies** and do not pay attention to the **text characteristics**, which could help them to find the needed information. Actually children do not know why navigational tools are there. For adults (for teachers) their function is obvious: they are there to help searching for information, children might think they are there to make the text more interesting and less boring. And as mentioned at the beginning of this article: just exposing children to a type of text does not necessarily make the better readers of such text. Each text type can (must) be approached with a special text reading strategy and each purpose of reading can be proceeded with the optimized strategy - and these strategies must be taught and practiced. This means **on the primary level reading of informational texts must become a part of curriculum,**

- skimming and scanning for searching and locating needed information in the text must be practiced,
- function of navigational tools must be explained and
- using text navigational tools as *strategy for finding information* must be practiced. (Brown, 2008)

Conclusion: Impact on education on primary level

What we need is an integrated science and literacy curriculum on the primary school level. But not like the past, when in integrated science and literacy curriculum the reading skill was taught (and practiced) mostly for reading literature and when stories, tales and poems were used for introduction of the topics in science class. We need integrated science and literacy curriculum which would improve learners' access to instruction in science, math, engineering, and technology. This would be particularly beneficial prior to the middle grades, when struggling readers begin to lose interest and choose nonscientific endeavors. Traditional approaches to science teaching used now do little to solicit student misconceptions, while they encourage teachers to gloss over scientific conceptual development. (Martens, 1999; Lederman, 1999). Furthermore current curricula in elementary schools are increasingly being focused on a narrowly defined view of literacy and skill-based programs still dominate elementary reading curricula despite research that shows process skills and content are not learned meaningfully out of context. (Yerrick, Ross 2008)

In the integrated science and literacy curriculum teaching and assessment in literacy, science, and technology could adopt successful strategies for teaching literacy in the context of inquiry-based science and technology instruction. These strategies would

- increase student motivation,
- build on children's prior knowledge and natural curiosity, and
- provide a context that enhances literacy instruction by expanding experiences and science vocabulary.
- They would teach writing about science topics,
- develop knowledge of text structures needed for communication about science topics
- give opportunity to practice successful strategies for learning from expository text that is encountered in the science, history, and mathematics textbooks and e-textbooks in today's classrooms, with different types of expository structures, which include descriptive, comparison and contrast, sequence, and cause and effect and
- provide students with skills, which can be used for locating the information in explicatory texts in their science textbooks, in the e-learning material and on the web using strategies of skimming, scanning and visual text characteristics.

References

Alexander, P.A., Schallert, D.L., & Hare, V.C. (1991). Coming to terms: How researchers in learning and literacy talk about knowledge. *Review of Educational Research*, 61, 315-343.

American Association of School Librarians. (1989). *Information power: Guidelines for school library media programs*. Chicago, IL: American Library Association.

Bertelsen, C. D., Fischer, J. M. (2008): *Mediating Expository text: Scafolding and the Use of Multimedia curricula*. http://www.reading.org/articles/bertelsen/index#html

Brown, G. T. L. (2008): *Searching Informational Texts: Text and Task Charactteristics That Affect Performance* http://www.reading.org/articles/brown/index#html

Chambliss, M.J. (1995). Text cues and strategies successful readers use to construct the gist of lengthy written arguments. *Reading Research Quarterly*, 30(2), 778-807.

Daniels, H. (2002). Expository text in literature circles. *Voices from the Middle*, 9(4), 7-14.

Denton, C. A., Fletcher, J. M. (2003). Scaling Reading Intervention. In. B. R. Foorman (Ed.) *Preventing and Remediating reading Difficulties: Bringing science to scale* (pp. 445-464). Trimonium, MD York Press.

Dreher, M.J. (1992). Searching for information in textbooks. *Journal of Reading*, 35(5), 364-371.

Harley, J. (1996). Text design. In. D. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 795-820). Mahwah, NJ: Erlbaum.

Lederman, N.G. (1999). Teachers' understanding of the nature of science and classroom practice: Factors that facilitate or impede the relationship. *Journal of Research in Science Teaching*, 36(8), 916-929.

León, J.A., & Carretero, M. (1995). Intervention in comprehension and memory strategies: Knowledge and use of text structure. *Learning and Instruction*, 5, 203-220.

Lorch, R.F., Jr., & Lorch, E.P. (1995). Effects of organizational signals on text-processing strategies. *Journal of Educational Psychology*, 87(4), 537-544.

Martens, M.L. (1999). Productive questions: Tools for supporting constructivist learning. *Science and Children*, 36(8), 24-27.

McGee, L.M., & Richgels, D.J. (1985). Teaching expository text structure to elementary students. *The Reading Teacher*, 38(8), 739-749.

Newman, G. (2002). Comprehension strategy gloves. *The Reading Teacher*, 55(4), 329-332.

O'Donell, A. (1993). Searching for information in knowledge maps and texts. *Contemporary Educational Psychology*, 18, 222-239.

Rosenblatt, L.M. (1995). *Literature as exploration* (5th ed.). New York: Modern Language Association of America.

Tompkins, G.E. (2001). *Literacy for the 21st century A balanced approach.* (2nd Ed.). Columbus, OH: Merrill Prentice Hall.

Waller, R. (1991). Typography and discourse. In R. Barr, M.L. Kamil, P. B. Mosenthal, & P.D. Pearson. (Eds.), *Handbook of reading research* (Vol. 2, pp. 341-380). New York: Longman.

Yerrick, K.; Ross, D. L. (2008). *I Read, I Learn, iMovie: Strategies for Developing Literacy in the Context of Inquiry-Based Science Instruction* http://www.reading.org/articles/yerrick/index#html

Yetton, T.L.; Alexander, P.A. (2008) *Learning from text: A Multidimensional and Developmental Perspective* http://www.reading.org/articles//handbook/yetton /index#html

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