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A READING CURRICULUM FOR THE HOMO ZAPPIENS GENERATION: NEW CHALLENGES, NEW GOALS

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Abstract. *A new model for a 21st century reading curriculum (RC), needed as a consequence of the changes made by new technologies on human brains in the last two decades, will be presented. Cognitive science warns that some of these changes can seriously threaten the science learning process in school. This of course has implications for the educational system – including, perhaps primarily, the RC. A RC for the "Homo zappiens" (HZ) generation should comprise of two kinds of reading competences: informative and explicatory reading/learning texts strategies (=off-line reading competence); ICT reading/learning strategies (= on-line reading competence). Both of these are essential for reading, especially for reading both types of natural science texts: those on the screen and those on the paper -in the natural science textbook and in the secondary science literature. The results of the meta-analysis, which was used to examine the basis for implementing a reading curriculum for Homo zappiens by natural science teachers in the near future, are an important part of our research. The question is crucial and relevant because research has proven a strong connection between reading competence, reading comprehension and learning success generally, particularly in a science field. The results have shown a strong absence of interest among natural science teachers regarding reading competence for comprehension of science texts.*

Key words: *comprehension strategies, reading strategies, natural science, science education.*

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Introduction

"Concerns about low student performance in basic skills, as revealed by international surveys, led to the adoption in 2009 of an EU-wide benchmark which states that *'by 2020 the share of 15-year-olds with insufficient abilities in reading, mathematics and science should be less than 15 %'*[1]" (Science, 2011: 3). However, are reading, mathematics and science connected?

Changing the medium of communication has always changed the way of thinking. Cognitive science warns that the change from traditional, linear reading-writing communication to punctual, verbal-visual communication in digital media can seriously threaten the science learning process in school (Science, 2011). The Internet promises to have particularly far-reaching effects on cognition – above all on reading competence, reading comprehension and ability to learn from written texts. P. Greenfield (2009) describes three types of positive changes in human brains as a consequence of exposure to new media and especially to video games. The new generation is quicker to grasp basic visual literacy skills, such as iconic representation, spatial representation, spatial visualization, and other visual skills, important in the virtual world of computers and consequently in science education, where visualisation is very important (Bilbokaité, 2012). This new generation has the ability to keep track of multiple events at different locations on a screen (divided attention ability) and can carry out more than one task simultaneously (multitasking). Not all this development however is a positive one: the changing balance of media technologies had also led to cognitive deficits in the field of scientific thinking, in the capacity to imagine and in the area of abstract thought (Greenfield, 2009). All this can strongly influence natural science teaching in school (Lamanauskas, 2007), although natural science education is rapidly moving toward an ICT teaching - learning model, we cannot neglect the fact that the natural science *text* is still the medium where students find natural

1 Strategic Framework for European Cooperation in Education and Training ('ET 2020'), Council Conclusions May 2008, OJL 119, 28.5.2009.

science information and natural science knowledge. There is no doubt that brain changes, caused by long media exposure do have implications for the educational system, including natural science education. These implications can go in two directions: a school can adapt its goals and teaching strategies to the new ways in which students' brains function, or it can recognize deficits and find ways to create environments that develop the missing skills students need to remain *"Homo sapiens".*

The first option is based on the extreme position that *Homo sapiens* no longer exists: he has already changed in to *Homo zappiens* (HZ) (Veen, Vraking, 2006). He has become a new species with highly developed iconic skills and can function freely in the multimedia world. HZ developed the pattern of *zapping behaviour*. As part of that behaviour, he *stopped reading in the linear way*. He developed the *strategy of scanning texts*: he reads only those paragraphs that seem most appropriate and those he is able to make sense of from the bits and pieces of information. According to this first option, linear reading is no longer suitable for *Homo zappiens*. A school should definitely adopt new strategies: more images and less verbal language; more e-material and fewer teachers; more iPads/notebooks and (as soon as possible) no textbooks.

The second stream goes in a different direction: a school should not only adapt to new circumstances but also compensate for the deficits that have emerged in the process of online activities. Wolf and Barzirllai (2009) suggest a two-track reading model: encouraging deep reading online, while preserving old fashioned linear literature reading. They point out that the digital culture's reinforcement of rapid attention shifts and multiple sources of distraction will probably short-circuit the development of the slower, more cognitively demanding comprehension processes that go into the formation of deep reading and deep thinking. Moreover they warn that if such a development occurs, we may lose the capacity for critical analysis or contemplative thinking processes.

By observing the concept of school adaptation by Veen and Vraking (2006) and Wolf and Bazirlai (2009) from a critical point of view, we could come to the conclusion that neither answers sufficiently to the circumstances. Future generations will read to get information, read to learn, read to solve (their) problems, read to manage their life, read to have fun and, last but not least, read (and write) to be part of a social network. For all this they need something different; they need something more; they need a Reading curriculum for *Homo zappiens* (RC for HZ). Part of this curriculum will involve natural science education and natural science teachers, because research has established a strong connection between reading competence (=reading comprehension) in a particular science field and learning success in this particular science field (Hus, 2013).

Theoretical Development - Reading Curriculum for *Homo Zappiens*

Young people use different media for different purposes. They read a range of paper materials throughout the day in various locations to gain knowledge, for pleasure, for mood change, to escape, and out of obligation. A study exploring the effect of the Internet on reading behaviour on an 18-year-old population (Herath, 2010) has once again shown how the different media evoke different reading patterns. With an increasing amount of time spent reading online, a screen-based reading behaviour emerges. Skim reading, scanning, and speed reading are leading to lower comprehension and content absorption/recall levels. There is a lower attention span for online materials, therefore less concentration (Herath, 2010). Birkerts (1994) further notes that generations growing up in the digital environment lack the ability to read deeply and to sustain a prolonged engagement with reading. Evidence suggests that these individuals are looking for small chunks of text and shorter paragraphs. Carr (2008) argues that online reading has decreased users' capacity to concentrate, contemplate and engage with information resources. Experimental findings have noticed and proven the discomfort and slowness of reading on screen. Chu (2003) states that people generally find it uncomfortable and do not prefer to read books on screen. Slower reading speeds and increased fatigue have been noted as other factors that discourage the reading of online articles (Shaikh, 2004). Hartzell (2002) also notes that reading speed from a monitor is up to 30 percent slower than reading the same text on a printed page. Document portability, the ability to highlight, and the ability to retain the original formatting, are other disadvantages for online materials, as opposed to printed media (Shaikh, 2004). Empirical data from Liu and Huang (2007) illustrate that people prefer reading on paper where there is a need to read lengthy documents or for in-depth reading and taking notes.

All this should have consequences for the reading curriculum for *Homo zappies*. His curriculum should not be oriented solely towards online literacy, because *Homo zappiens* will also need the capacity for off-line, in-depth reading of informative and explicatory texts. Moreover, he needs the competence for reading fiction – not only to attain inculturation, multiculturalism and tolerance toward others but also to develop imagination and the level of inductive and abstract thinking. To obtain good results in all three areas, a new reading curriculum must also focus on developing an advanced level of basic reading skills.

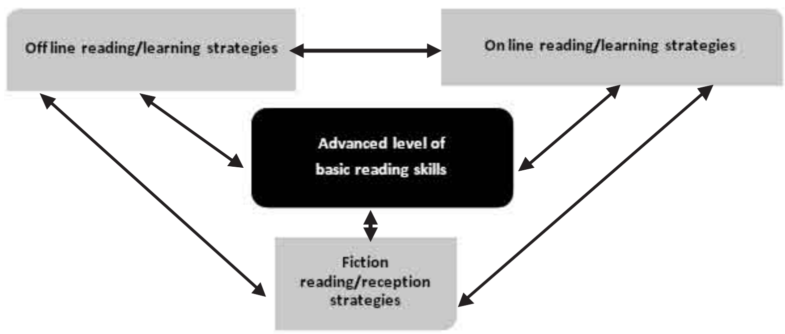

Figure 1: Structure of *Homo zappiens* reading curriculum.

All four structural elements of RC for HZ are connected with natural science education: it is crucial for the natural science learning process that students reach the level of abstract thinking and acquire the capacity for inductive thinking. Not many problems in physics can be solved, not many topics in chemistry can be understood and not many invisible laws in biology can be imagined without the capacity for abstract thought, the ability to imagine what cannot be seen, and without the inductive thinking process. The RC for HZ supports counteraction of these thinking deficits by using the literature didactic approach in the mother tongue class. However the other three structural elements of RC for HZ – advanced level of basic reading skills, on-line reading/learning strategies and off-line reading/learning strategies – must be partly integrated into biology, chemistry, physics and technical education classes.

Advanced Level of Basic Reading Skills

Reading is an activity requiring a wide variety of cognitive skills to decode, comprehend, and learn from a text. Although nowadays reading is regarded as a multidimensional activity in which readers make inferences and bring prior knowledge to the reading task, we must remember that the decoding skill – the basis for all that – cannot be skipped. It is a fact that all teachers will confirm: the *Homo zappiens* generation has more difficulty in learning decoding skills than generations before them. This is the consequence of the divided attention and multitasking ability that they develop online. Parallel to this, they lose the ability to fix the reading line with their eyes. Regressive eye movements are more frequent, and after such regressive movement, *Homo zappiens* has more difficulty in finding "where he was". After acquiring decoding skill, students have to reach a level of fluency. Fluent reading involves accurate and automatic word recognition. There is a reciprocal relationship between fluency and comprehension. The more fluent the reader, the more likely it is that he or she will understand a text.

Although automatic word reading does not necessarily guarantee fluency, it is obviously an important aspect. Ehri and Wilce (1983) have described the process of developing automaticity in word reading. With repeated exposure to words, the process of connecting the sound, the spelling, and the meaning becomes less effortful. Such connections allow words to be identified "by sight". Once children have become familiar with basic sound-letter correspondences, there is a need for them to work on becoming automatic in their word reading in order to make the transition from *learning to read* to *reading to learn* (Rice, 2009). Automaticity should be taught separately for each school subject. Let us consider mathematics and science class. A textual assignment in a mathematics and science textbook uses very limited vocabulary. Fluent, "by sight" recognition of those words would significantly raise the mathematical and science efficiency of students, if we imagine that students use almost all their mental energy for solving mathematical and science problems and not waste it on reading energy (Science, 2012).

The next important component of the basic reading skill is vocabulary. There is a significant gap in the vocabulary knowledge that some students bring to the primary grades, and that gap widens as students progress through the grades. Students who lack adequate vocabulary have difficulty constructing meaning from what they read. It is a great misconception that students learn vocabulary mainly in the mother tongue class. In fact they learn the majority of words in their science education. Every teacher, also natural science teacher, is responsible for vocabulary in his science field. Consequently, a natural science teacher is responsible for teaching students to decode the meaning of unknown words in the natural science textbook of his subject, using special for his subject designed decoding strategies.

Metacognition involves children's knowledge of and control over their own thinking and learning activities, including reading. Paris et al. (1983) categorized knowledge about strategic reading in three ways. Declarative knowledge about reading includes an understanding of *what* factors influence reading. Procedural knowledge reflects an appreciation for *how* skills operate or are applied in particular kind of text. Finally, conditional knowledge is an understanding of the occasions *when* particular strategies are required and *why* they affect reading. The natural science teacher is responsible for encouraging metacognitive thinking about the cognition process in his science field.

Most aspects of reading - from basic decoding skills to higher-level comprehension skills - need to be explicitly taught. The experts agree that skilled reading and understanding rarely emerge without guidance and instruction. This also means that on-line reading/learning strategies, literature/reception reading strategies and off-line reading/learning strategies must be taught / developed separately.

On-line Reading/Learning Strategies

There is no doubt that digital media are different from printed reading materials, therefore reading strategies for reading information and explanation on-line must be taught in school. Teachers must learn to understand what happens when students are learning on-line and how to scaffold this learning to become more efficient. More attention must be oriented to the question of how readers actually engage with different media, their reasons for choosing one format over another, and their satisfaction with each format.

With the growing amount of digital information available and the increasing amount of time that people spend reading digital media, the electronic environment has begun to affect people's reading patterns and behaviour. Studies of digital media and its effect on human reading behaviours have yielded mixed conclusions. While some researchers have identified powerful advantages to digital media, others have criticized the effect of the internet on human cognition and reading capabilities. The challenge is to determine the applicability of a particular medium in a given context or for a particular process. The ability to embed multimedia in reading content, interactivity, ability to search the content, and better information structures are identified as other key benefits of digital media (McPherson, 2005; Ross, 2003). Many studies show that online reading and reading on the web provide a sophisticated reading experience because readers must process the information in so many different forms, such as photograph, audio clips, videos, charts, and graphs (Herrath, 2010).

Different types of digital texts require different skills, strategies and dispositions, to read and navigate them. It is important that natural science teachers understand these differences and integrate digital technology into the curriculum to provide students with opportunities to learn these new literacies. Moreover these new science literacies demand new didactics. One of the newest is iPad didactics. Although mobile learning in education has been on the horizon for many years, the introduction of the iPad and other tablets like it has changed mobile learning possibilities for teachers and students. Mobile learning means learning that is supported or delivered by a handheld or mobile device. Such

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mobile devices encourage learning through their ease of portability and the access to information that can allow learning to occur. Devices such as the iPad now promote anytime, anywhere learning in schools where the student does not have to be sitting in front of a computer in a laboratory setting (Brand, Kinash, 2010). The iPad has unique capabilities that were unavailable prior to its introduction (Hutchison et. al, 2012). It has most of the capabilities of a desktop or laptop computer, but with additional unique advantages, such as a touch screen and a seemingly endless variety of applications that promote previously unforeseeable possibilities for mobile learning.

As teachers began exploring the possibilities for using mobile devices such as the iPad in their classrooms, they had to examine how this technology, with its advantages and constraints, can influence student learning. It is important to consider that digital texts, as compared with printed texts, offer different features that create new modes of reading and writing (Leu, 2006).

The iPad has numerous downloadable books, including natural science books as well as fictional, which also include the ability to acquire the definition and pronunciation of any word on the screen by simply touching it, and to add notes or highlighting to any section of text by tapping the screen (Hutchison et. al, 2012). Additionally, the many forms of electronic books available through the iPad provide an added advantage over printed texts, since they provide further opportunities for students to physically interact with and manipulate texts and to transform texts to meet their needs and interests (Eagleton, Dobler, 2007), making the reading experience more individualized, interactive, and engaging (Larson, 2010).

Further possibilities of the iPad for natural science class include apps that might facilitate responses to text. Apps are applications created for digital devices, such as tablets and smart phones, to serve a single, specific function and can be downloaded wirelessly or by connecting to a computer.

Table 1. List of iPad Apps Used for Instructional Activities (Hutchison et al, 2012: 19).

Reading skill or area addressed	App	App description	Description of literacy activities
Independent reading	iBooks	Tool for downloading and organizing books	Accessed books from the bookshelf of iBooks. Dictionary and note-taking features were available.
Sequencing	Popplet	Mind mapping or brainstorming tool using text and/or images	Worked in small groups to order the events of a short story using words such as first, next, and finally
Visualization	Doodle Buddy	Drawing and doodling tool with stamps and backgrounds	Small groups read a sentence from a text they were reading and created a picture to illustrate the paragraph. The teacher then displayed all of the pictures together to show the complete story before reading.
Retelling	Strip Designer	Comic strip tool	Drew pictures of the beginning, middle, and end of a story using Doodle Buddy and used them to retell the story in Strip Designer
Cause and effect	Sundry Notes	Productivity tool used to type text, draw, record audio and more	Drew pictures of a cause and effect from an instructional level text and inserted an audio recording explaining the picture.
Main idea and details	Doodle Buddy	Drawing and doodling tool with stamps and backgrounds	After reading an instructional-level book, students drew a picture to illustrate the main idea and details of a text

Apps that appear promising for educational purposes are those that allow users to type or write on top of printed text or other backgrounds, to record audio for a response, to add pictures from the photo library, to insert symbols and stamps, and to graphically organize responses in virtually limitless ways. In addition, the iPad's built-in camera provides opportunities for the user to easily capture a photo or video for inclusion in a response.

It is easy to see the potential inherent in mobile devices such as the iPad for natural science classrooms, but as with any digital technology, it is imperative to examine how the tool can help natural science teachers meet curricular goals. To be clear: the goal is to achieve curricular integration and not only technological integration (Hutchison, Reinking, 2011).

Off-line Reading/Learning Strategies

Natural science teachers encourage students to use ICT texts for information and for informal and formal learning. In many cases the digital language and digital communication are the most efficient ways to find information or to learn about nature. However, this is not always the case when one considers reading and learning situations – above all, when one considers learning from longer expository texts. In those cases, on-line communication seems to have serious disadvantages: as mentioned, on-line reading speed is 30% slower than on the printed page; on-line text is inviting, not for deep reading but for skimming, and skipping – and if the reader wants to avoid this and force himself to read deeply, he uses considerable mental energy to motivate himself and stay focused. Last but not least, the on-line "reading condition" is weaker than reading condition while reading on paper: a reader gets tired because he must constantly fight again his natural tendency towards the distractions, offered by e-pages, to provoke clicking. In consequence, a reader who wants to learn from a natural science text, who wants to remember what the text is about, who wants to read deeply and critically, will most probably print the online article in which he is interested and study it off line.

Moreover because all aspects of reading — from basic decoding skills to higher-level comprehension skills — need to be explicitly taught, reading and comprehending paper printed natural science explicatory texts for formal and informal reading/learning must also be a part of the RC for HZ.

Research consistently points to the direct relationship between learning to read, comprehension and learning success. The conceptualization of comprehension as a problem-solving process has guided much of the instructional research on the topic during the past 30 years. This research has provided a clearer vision of how best to help students acquire and use the strategies and skills that foster good comprehension. Several general characteristics of effective strategy instruction have arisen from this body of work. First, we know that it is important for instruction to be explicit. The teacher makes silent thought processes obvious to the student through modelling, demonstrations, and guidance. Secondly, it is important for the teacher to provide temporary support, or "scaffolding," to help the student move toward independent application of strategies and skills, and the long-term goals of maintenance over time and generalization to related reading. It is important that teaching comprehension is sustained over time: effective strategy instruction must be an integral part of reading instruction on an on-going basis and in the frame of all fields – natural and social science fields, students are taught in school (Rice, 2009).

It is undeniable that comprehension of the text must be taught / modelled. It is only recently that researchers have begun to understand how readers comprehend what they read and how to break down this task of comprehension into steps that can be taught. A well-constructed reading/learning strategy not only helps students to acquire information and develop concepts, but also walks them through the thoughtful, strategic processes by which they acquire information and develop concepts at various levels of comprehension. For the purpose of this study we shall take a closer look at one of the specific comprehension strategies, adopted from Fisher, Frey and Lapp (2009) –because it is quite flexible and useful for different kinds of texts and for texts in different scientific fields.

Table 2. The list of Comprehension strategies that can be modelled.

Strategy	Definition
Establishing Purpose	Identifying and understanding, why something is being read.
Inferring	Understanding the implied information.
Identifying Text Structure	Recognizing the pattern of the text and organizing text information according to this pattern
Summarizing and Synthesizing	Identifying the major points, ideas from the selection.

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Strategy	Definition
Predicting	Using available information to make an educated guess about what might happen next.
Questioning	Maintaining an inquiry focus before, during and after reading
Visualizing	Creating a mental image of the text in the reader's mind.
Monitoring	Noticing when comprehension is lost and applying strategies to regain meaning
Determining Importance	Finding the main ideas and separating them from details
Connecting	Relating the text to personal experience, other readings, and the world.

This list of comprehension strategies gives insight into the particular elements of processes that can have a positive influence on understanding also of natural science texts. Understanding the structural elements of students' comprehension gives the natural science teacher the opportunity to develop these elements of students' comprehension; he judges what would be most important for learning from the explicatory text, with a typical structure for presenting the scientific field he is teaching.

Fiction Reading/Reception Strategies

As has been established, the readability of on-line text is quite poor in comparison to reading on paper. Reading is an activity that requires focused attention for an extended period of time. When a person reads a narrative, he/she creates pictures in his/her mind to go along with the story. So, reading books is a mentally stimulating activity. From that perspective, literature education will gain new assignments in the RC for HZ. It will not only brighten the cultural horizon, encourage inculturation and multiculturalism but also develop the empathic skills of the student. Reading fiction will also create excellent circumstances for compensating/avoiding those deficits which occur after overly long exposure to computer texts. This is because the reader in the process of reading fiction activates and develops cognitive activities, such as reflection, indicative analyses, critical thinking and imagination.

Creative imagination is a potential that can be developed in a stimulative environment or can stay untouched, dormant in the environment of watching television or other new media. A receptive situation while reading or listening to literature confronts a reader with scant data (textual clues) that he could use for creating an eidetic picture of literary persons and setting. Reading and listening to fiction are *simulating in the development of creative imaginary capacity of the brain* (Kordigel Aberšek, 2012).

Inductive analysis is a cognitive process used on many levels of the reception process. One of these concerns the decision whether the literary text is a fantasy, or if it pretends to be a copy of reality. The first decision a reader must make is the choice between *reality and fiction.* As the first step in making this decision, he must evaluate the textual clues according to criteria described by D. Buckingham (1993). After this general decision, a reader must accomplish a process of ontological classification (Lem, 1984). He must choose the zero point of his observation – which is his experience of reality – and then, from this point of view, he must decide what kind of text is he reading: is it myth, ghost story, science fiction, fairy tale or fantasy? Each of these literature genres has its own system of rules. Ontological classification of the literary world using one or the other system of rules enables the reader to construct coherent meaning from the literary work, to make his own sense of the textual clues – to build his own meaningful interpretation (Kordigel Aberšek, 2012). Reading fiction will *develop students' brain capacity for inductive analysis*.

The most crucial deficit for natural science education is the lack of capacity for critical thinking, especially on the abstract cognitive level. Reception of literature offers the opportunity for *Homo zappiens* to develop critical and abstract thinking and so to avoid the kind of deficit resulting from long exposure to computer texts. To construct a reflexive meaning for the text, students take a look at the literary world from the author's perspective - to understand his communicative intents; moreover, they must (critically) evaluate the literary world from perspectives external to the text: from the perspective of the ideology behind the text, from the social perspective, from the class perspective, from the historical perspective of the time and place... All these are abstract categories, and to construct a reflexive meaning of the literary work, to notice all this, the reader must use the cognitive process of generalization and abstract thinking (Kordigel Aberšek, 2012, Aberšek, Kordigel Aberšek, 2010).

After listing and defining all four structural elements of RC for HZ, it should be pointed out that all four of them are strongly connected: advanced basic reading skills, on-line literacy, off-line literacy and fiction literacy. Becoming better in each of them contributes to reaching a higher level in the other three areas of literacy. For example: having more words in the vocabulary contributes to better comprehension of the on-line text, of the off-line text and of the fictional text, and vice versa: reading fiction, reading off-line/textbook text and reading on-line text contributes to vocabulary as an element of advanced basic reading skill – which is used in all other reading/learning situations. Let us take another example: reading online encourages the skimming and skipping skill. It becomes part of the advanced basic reading skill and is very useful as a prereading strategy for reading and learning off-line. A reader skims the text, recognizes the text structure, prepares the relevant mental scheme, and prepares expectations about what can be learned from the text. Yet a third example shows that reading fiction will influence the reading fluency, useful for all other types of literacy – and it will encourage the development of imagination, abstract thinking and inductive thinking – essential as much for on-line reading skill as for off-line reading competence. Last but not least, each reading performance contributes to the development of metacognition – of declarative metacognitive knowledge (e.g., knowing *that* skimming is a reading strategy), of procedural metacognitive knowledge (e.g., knowing *how* to skim), and of conditional knowledge (e.g., knowing *when* to skim and *why)*. It also develops the skills required to evaluate, plan, and regulate one's thinking and reading.

Methodology of Research *(Implementation of the Reading curriculum for Homo zappiens)*

It seems that creation the RC for HZ has solved the problems with literacy, functional literacy, and competence in using reading to gain information, for solving problems and to learn on-line and off-line. RC for HZ is based on the needs of new generations; it is adapted to the digital world of the 21st century and is also adjusted to the strengths of an e-generation that has spent thousands of hours in front of all kind of screens, as well as to their deficits, which occurred on account of the same hours spent in front of the (computer) screen. So, in the first place its implementation should not proceed with any difficulties, since all school system authorities in all European countries have recognised the need to include literacy competence, digital competence and competence to learn in their curricula. Nevertheless each change in the school system goes through people. Thus any change in the reading curriculum paradigm can happen only with the cooperation of the relevant scientific audience, and above all, of teachers in schools.

So, what are the chances of RC for HZ being implemented by natural science teachers now? It is important to find the answer to this question by examining a part of RC for HZ: *comprehension strategies that can be influenced by the teacher*. It was decided to chose the above mentioned Fisher, Frey and Lapp list of comprehension strategies, because these strategies are extremely universal and thus suitable for raising the comprehension level in almost all kinds of texts in almost all scientific fields, and because they can be used by any group of natural science teachers to raise comprehension in the field of his natural science subject.

Methods and Sampling

The aim of research was to examine the foundation for implementation of RC for HZ theoretical model in the near future. This was done with meta-analyses and a pilot (with small sample) single research study under a given single set of assumptions and conditions. So, two methods were combined to establish the following relations:

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- Between the general scientific view about the importance of comprehension strategies and the view of natural science scientists and
- Between the presumption of scientific community of natural science and the practical responses of natural science teachers in schools.

Meta-analysis refers to the statistical analysis of a large collection of independent observations for the purpose of integrating results and refers to methods focused on contrasting and combining results from different studies, in the hope of identifying patterns among the study results, sources of disagreement among those results, or other interesting relationships that may come to light in the context of multiple studies (Glass, McGaw, Smith, 1981). In its simplest form, this is normally by identification of a common measure of effect size, of which a weighted average might be the output of a meta-analysis. The general aim of a meta-analysis is to more powerfully estimate the true effect size, as opposed to a less precise effect size derived in a single study under a given single set of assumptions and conditions.

The benefits of meta-analysis include more effective exploitation of existing data from independent sources and contribution to more powerful domain knowledge. It may also serve as a support tool for generating new research hypotheses. The idea of combining results from independent studies addressing the same research question dates back to the sixteenth century, and meta-analysis was reinvented in 1976 by Glass (1976).

For the meta-analyses, meta data from the Web of Science (WoS) data base were used, and for the single research study, a questionnaire was distributed between 50 natural science teachers in Slovenia. They were chosen deliberately and randomly, at the same time. "Deliberate" part of sample selection was the decision to choose the group of science teachers who served as mentors for students during their practice weeks in schools in the 8th semester of their pedagogical study program in the 2011/2012 school year. It was assumed that those teachers who serve as mentors for students would be more interested in didactical innovation and would read more scientific papers. The "random" part of sample selection was the circumstance that we did not plan who would serve as mentors in that particular school year. In the end, the sample of teachers was made up of 32 biology teachers, 9 chemistry teachers, 5 physics teachers and 4 teachers of technical science.

Data Collection

In the meta-analyses, two kinds of key words: constants and variables were used:

- *The constant key words* were as follows: reading and comprehension strategies, for the general case (Column 1), and for science case (Column 2) the word "science" was added, and
- The *variable key words* were names of the corresponding comprehension strategies.

For the single research study, a questionnaire was used. This simple questionnaire was composed of only two questions:

1. Which of the listed comprehension strategies could you use to model text comprehension in the textbook for your subject?
2. Sort the chosen comprehension strategies according to your judgement of their importance from 1 to 11.

It was assumed that natural science teachers would lack extensive knowledge about reading. To avoid any misunderstanding connected with terminological problems, the Fisher, Frey and Lapp list of comprehension strategies that can be modelled, which was given to teachers, didn't use names of the strategies, like "establishing purpose" or "predicting", "monitoring". Instead of that, the definition was used: "identifying and understanding why something is being read", or "using available information to make an educated guess about what might happen next", or "noticing when comprehension is lost and applying strategies to regain meaning".

Results of Research

Results are presented in Table 3. The number of papers and the number of citations are analysed and compared with teacher opinions. The results are presented in Figures 2, 3, 4 and 5.

Table 3. Results.

Strategy	WoS - general		Citation		WoS for Sci				From	Teacher analyses	
	1-No.	2-f	3-No.	4-f	5-No.	6-f	7-No.	8-f		9-No.	%
1. Establishing Purpose	4	0.6	12	0.15	0				2006	0	0
2. Inferring	16	2.5	201	2.43	0				1992	0	0
3. Identifying Text Structure	18	2.8	344	4,2	0				1992	0	0
Summarizing and Synthesizing	0										
4. Summarizing	59	9.2	876	10.6	0				1996	12	24
5. Synthesizing	12	1.9	156	1.9	0				1993	5	10
6. Predicting	95	14.8	1253	15.2	0				1991	0	0
7. Questioning	294	45.9	3861	46.8	34/15	68	916	88	1984	50	100
8. Visualizing	7	1.1	9	0.1	2/0	4	8	0.8	2000	21	42
9. Monitoring	107	16.7	1366	16.5	12/3	24	99	9.5	1984	0	0
10. Determining Importance	6	0.9	17	0.2	0				1992	9	18
11. Connecting	23	3.6	163	2	2	4	18	1.7	1992	5	10
Total	**641**	**100 %**	**8255**	**100%**	**50/20**	**100%**	**1041**	**100%**		**50 teachers**	

The results show a quite dispersed attention among the general science research towards all comprehension strategies, although strategies 6, 7 and 9 receive the majority of the scientific research, which is also confirmed by the correlation between the number of published papers and their citation. Moreover the history of scientific research on comprehension strategies is not without influence on the results, presented in the table: the first scientific papers about the earliest research date from 1984, in comparison with that, *visualisation* is the "youngest" among them, but the scientific interest in this strategy is undoubtedly growing (Lamanauskas, 2007, Bilbokaite, 2012). At the same time, we cannot fail to observe the modest number of papers focused on Strategy 8 (=visualisation), which can be explained by the fact that scientific interest in this strategy began after 2000. The same explanation can be used for the correlation between the number of scientific papers and the number of citations, which on this area is 10:1.

The next discrepancy to which must be draw attention is the difference between the number of scientific papers about different types of comprehension strategies produced (and quoted) by *general* and *natural scientists*. It is obvious that the natural scientists find Strategies 1 - 6 and Strategy 10 completely unattractive. Strategy 7 Questioning seems to be for the natural scientists twice as important as it is to the general scientific community (88%: 45.9% -number of quotations and 68%: 45.9% - number of articles). All other comprehension strategies seems to be completely unimportant for natural science; with the exception of Strategy 9, which seems to be "somewhat important" (9.2% article and a similar % of citations).

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The analysis of diagrams in Figures 2-5 gives us the answer to the central question of present research: what are the chances for quick implementation of the RC for HZ?

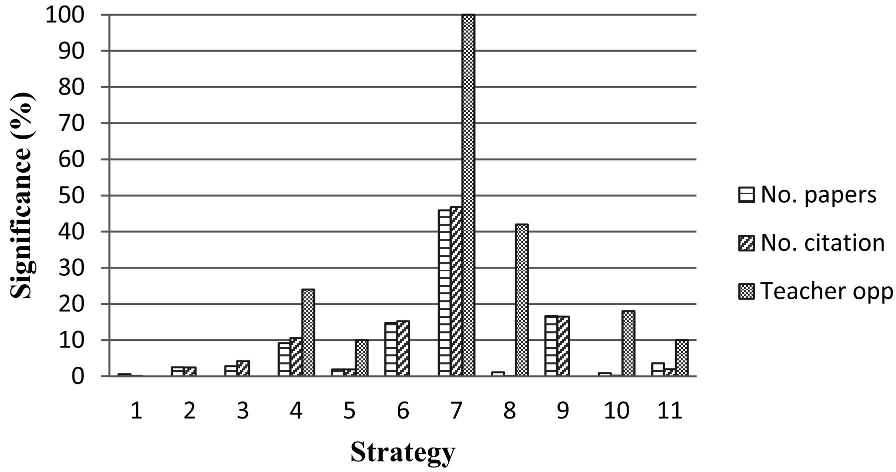

Figure 2: Correlation between all scientists' and teachers' opinion.

Figure 2 shows the correlation of research focus between *all scientists* and *natural science teachers* who are currently teaching in school. One can observe that natural science teachers mention as important for their school subject only summarizing and synthesizing, questioning, visualisation, monitoring and connecting. They evaluate as the most important questioning, synthesising and visualisation, and they do not even mention establishing purpose, inferring, monitoring or connecting. Not to mention that they do not see any importance in helping their students to understand the text in the textbook of their subject by identifying the (typical) text structure of their science texts.

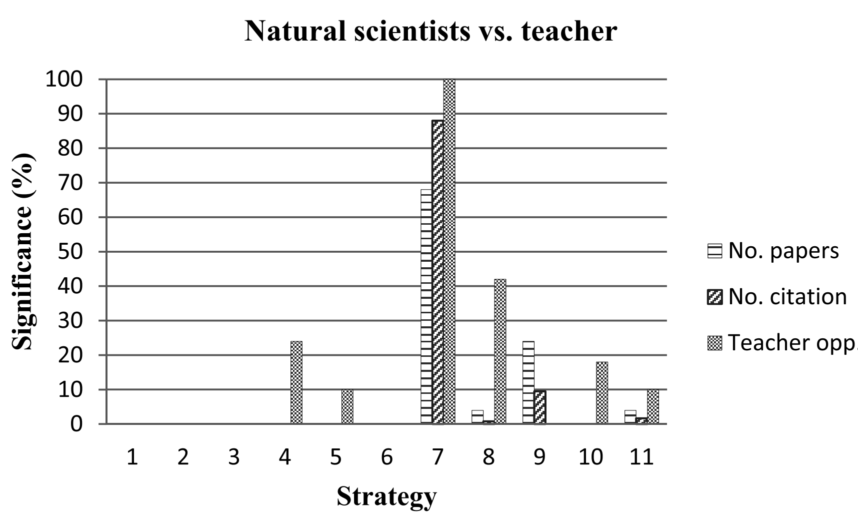

Figure 3: Correlation between natural scientists' and teachers' opinions.

Figure 3 shows the correlation of research focus between *natural scientists* and *natural science teachers*. One can see a bigger correspondence in evaluation of the importance of questioning between natural scientists and natural science teachers than that between general scientists and natural science teachers. A big discrepancy between teachers' opinions and scientific interest appears in the fields of summarizing, synthesizing and determining importance, which teachers find rather important, but which get no attention from the scientific community of natural science. A remarkable difference can also be observed in the field of visualization: teachers evaluate it as quite important, on the one hand, on the other; it seems that natural science still hesitates to focus its research on it.

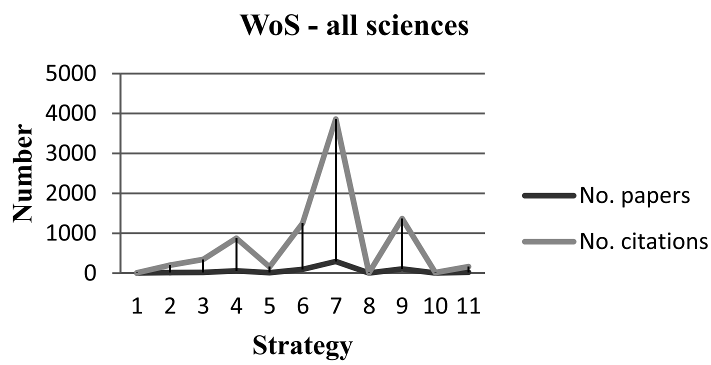

Figure 4: Correlation between number of papers and corresponding citations for all sciences.

Comparing the results of Figure 4, which shows the number of papers and corresponding citations for all sciences, and Figure 5, which gives the number of papers and number of citations for natural scientists, one can observe that they show a quite similar research focus for both groups of scientists. The majority of research interest is oriented towards exploring the role of questions in the comprehension process (although this interest in twice as great among natural science scientists). A similar equality of interest between science general and natural science marks comprehension strategies 6 and 9 (predicting and monitoring); somewhat lower (but similar in quantity) interest is attracted by the comprehension strategy of summarizing.

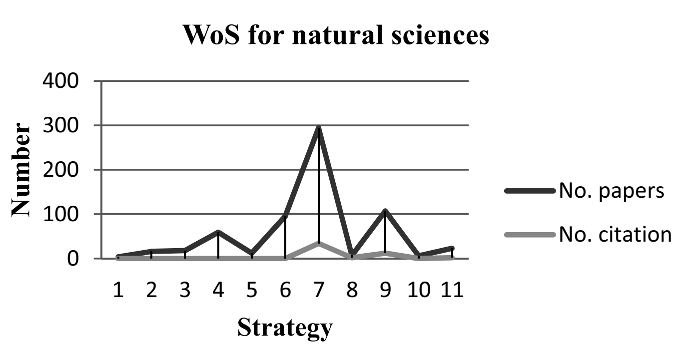

Figure 5: Correlation between number of papers and corresponding citations for natural sciences.

Comparing these results with the teachers' evaluation of the importance of a particular comprehension strategy for their science class, a great discrepancy can be observed. Consensus can be observed only in opinions about the importance of questioning. The importance of the other 10 comprehension strategies is judged differently or even in a completely contrary manner: teachers find these unimportant (or unknown?).

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Discussion

The results presented in the paper provide the answer to the central question of our research: what are the chances for quick implementation of the RC for HZ? The basic idea of RC for HZ is the interdependence between an advanced level of basic reading skill and off-line, on-line explicatory and informational learning/reading competence, which cannot be developed only by mother tongue teachers. To focus only on comprehension (and neglect vocabulary and absence of content knowledge), we can easily understand that mother tongue teachers cannot teach using comprehension strategies such as questioning, monitoring, determining importance and connecting, for texts providing chemistry knowledge, technical knowledge or biology knowledge. This is something only natural science teachers can do. Moreover only natural scientists can develop didactic knowledge about useful comprehension strategies, a chemistry teacher, a biology teacher, a physics teacher, a geography teacher can use to help his students to comprehend better the text in the chemistry, biology, geography textbook or to comprehend better the on-line text, he is using in his chemistry, biology, geography class. On the secondary level the problem is even more urgent: the texts, students read in the biology class, chemistry class, physics class are informational or explicatory and differ in structure from each other. Natural science texts on secondary level differ from those on the elementary level, where they are more or less similar for all natural sciences. It is important that natural science teachers identify this differences and determine how best help students to in comprehending those variety of texts (Blachowicz & Ogle, 2001). It is concerning when results of the meta-analysis presented in the article show a discrepancy between general scientists and natural scientists research focus: the latter's ones research is focused on a limited area of necessary research, connected with the strategies teachers could use to help their students better comprehend their natural science texts. Of even more concern is the discrepancy between research and teaching reality. Natural science teachers seem to be familiar with only a limited number of the comprehension strategies that could be useful in helping students to better understand what they are learning from natural science textbooks or/and from the screen. The results seem to confirm Sadler's (2011) statement, according to which "many middle school teachers are uncertain how to approach instructing students who have difficulties in text comprehension" (Sadler, 2011, p. 2). And according to Radcliffe, Caverly, Hand and Frank (2008) every teacher should have the necessary knowledge and skills to integrate reading thought his content areas. Assisting students with strategies for comprehension provides them with skills to use these strategies independently as they encounter more complicated texts when they learn biology, chemistry and physics... on the upper secondary level, on university level or in the process of lifelong learning. Comprehension strategies on these levels of reading include both: building background knowledge and reading comprehension strategies (Marcell, DeCleene, Juettner, 2010). There is no doubt, that this can be done only by biology, chemistry, geography ... teacher, since nobody else could possess competence to combine background knowledge and reading comprehension didactic knowledge. These points of view confirm the conclusions of presented study about the seriousness of the problem, connected with lack of knowledge and lack of interest for comprehension in the process reading and learning online and offline by natural science and natural teachers.

Conclusions

The discrepancy between theory and practice in the field of on-line and off-line reading competence is huge. The need to change existing functional reading didactics is urgent, but the opportunity to implement a new reading curriculum, a reading curriculum for the new generation – the *Homo zappiens* generation – seems limited. The present research gives us the liberty to conclude:

- That scientists do not focus their research in a sufficiently applicative direction, and that
- Natural science teachers are insufficiently acquainted with the new trends in didactics of their scientific fields.

From meta-analyses it can be pointed out especially the discrepancy between the number of scientific papers about different types of comprehension strategies produced (and quoted) by general and natural scientists. It is obvious also that the natural scientists find Strategies 1 - 6 and Strategy 10 completely unattractive and *questioning* seems to be for the natural scientists twice as important as it is to the general scientific community.

From comparison of results it can be also observed similar research focus for general scientists and natural scientists, but bigger correspondence in evolution are between natural scientist and natural science teacher. A remarkable difference can be observed especially in the field of summarizing and visualization.

There are also several limitations in the present study. This research was done with small number of teachers who served as mentors for students of biology, technical science, physics and chemistry study programs on the Faculty of natural sciences at University of Maribor, Slovenia in one single year. Thus to check whether these results are general, the sample of more teachers from variety of faculties from the field of natural sciences is needed. Secondly, the sample of teachers should be divided in to those, which serve for a longer period of time, and those, who had graduated in last few years. Also further research should include the comparison of standpoints, knowledge and interest for scaffolding students' on-line and off-line reading comprehension between future teachers of natural science subjects (now students at the university) and teachers who teach for a longer period. Also the comparison between teachers and future teachers who teach on the upper secondary level (students who are preparing themselves to teach on upper secondary level) and those, who are teaching (who will teach) on lower secondary level should be investigated. Such research would give the insight into the relationship between background knowledge and reading comprehension didactic knowledge, each of these groups is interested in.

The results would open the possibility to focus on strategies for solving the on-line and off-line reading comprehension problem for each of these groups differently – to design a curriculum focused on their knowledge deficits and on their deeply rooted forejudgement of science teacher: 'If I have to teach students also the reading competence, why do they need mother tongue education!' Such prejudices are not rare and they confirm the conclusions of presented study about the seriousness of the problem, connected with lack of knowledge and lack of interest for comprehension in the process reading and learning online and offline by natural scientists and natural science teachers.

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