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When the print meets the screen: Towards a model of L1 and L2 reading comprehension

ABSTRACT
The spread of information and communication technologies (ICTs) has been changing literacy practices and activities. Consequently, the traditional view of literacy as the ability to read and write needs to be revised to encompass new forms of literacy called e-literacy, or "digital/silicon/electronic literacies" (Murray & McPherson, 2006, p. 132) as well as "hyperreading" (Usó-Juan & Ruiz-Madrid, 2009, p. 59). The members of the 21st century "global", "fluid" and "networked" (Jewitt, 2008) societies engage in activities that the access to the WWW makes possible.
The aim of the paper is to discuss print-based models of reading, identify similarities and differences between online and offline text comprehension, also with respect to the foreign/second language (L2) reading. Online texts entail the necessity to use different sets of skills and strategies which have to be incorporated into a model of electronic text comprehension. Suggestions as to what such a model might include, based on theoretical underpinnings and empirical findings, are presented.
Keywords: offline and online reading, models of reading, foreign/ second language reading comprehension

1. Introduction

In the 21st century, ways of getting information, acquiring knowledge, communicating with others, exchanging views and opinions, doing shopping, getting entertainment, or establishing formal or informal networks have been changing due to a fast progress in information and communication technologies (ICTs). ICTs have also had an impact on employment, professional qualifications and working conditions. To get information, knowledge, and skills, the 21st century citizents have access not only to traditional, printed materials but also unlimited possibilities to use vast and varied resources available on the Internet. This suggests that traditional literacy skills, understood as the ability to read

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and write, do not suffice to effectively use the available resources. An ability to read both traditional and digital texts is indispensable in contemporary media landscape.

Reading in any language is ”the process of receiving and interpreting information encoded in language form via the medium of print” (Urquhart & Weir, 1998, p. 22) which entails text decoding and comprehension. It is “the ability to extract visual information from the page and comprehend the meaning of the text” (Rayner & Pollatsek, 1989, p. 23). Both definitions refer to “print” and “page”, the two elements that are absent in online texts that are not printed nor do they physically appear on page but on the computer (or other mobile device’s) screen. The reader’s interaction with the text is modified by the nature of this text. Currently communication has moved from “*telling the world* to *showing the world*” (Kress, 2003, p.117, italics in the original).

Reading involves interaction between the reader and the text, both conventional and digital. Electronic versions of conventional texts derive from print in terms of language use and structure while Internet-specific texts “include texts such as web home pages or the texts produced by search engines” (Lipscomb 2002, as cit. in Murray & McPherson, 2006, p. 134), blogs, Wiki, short text messages and e-mails (Braun, 2007), and many other. While printed texts are linear, static, bimodal as they contain language and graphics, neatly divided into pages read one by one, from the left to the right, Internet-specific texts are dynamic, multimodal non-linear hypertexts that are read from the top to the bottom (Coiro, 2003; Coiro & Dobler 2007; Piasecka, 2012, 2013; Usó-Juan & Ruiz-Madrid, 2009). Multimodality refers to the fact that these texts

> integrate a range of symbols and multiple-media formats including graphics, animated symbols, photographs, cartoons, advertisements, audio and video clips, virtual reality environments, and new forms of information with non-traditional combinations of font size and color (Coiro, 2003, p. 459–460).

Given such a wealth of multiple information formats, the person processing an Internet text has to decide what to focus on, how not to get distracted from the main purpose of reading the text, to understand what has been encoded in a variety of forms and relate it to their knowledge structures. Researchers concerned with online text comprehension (Coiro 2003; Coiro & Dobler 2007; Murray & McPherson 2006) agree that it shares a number of similarities with offline reading comprehension. It includes lower and higher level processes pertaining to print text comprehension that lead to developing a personal interpretation of the text. In addition, due to multimodality, the meaning of Internet-specific texts is not limited to language used in them but it is also shaped by acoustic, spatial and visual modes of communication (Rowsell & Burke, 2009). These require new skills and strategies that will help the reader process such texts successfully.

The following section presents L1 reading comprehension models that have been developed on the basis of theory and empirical findings pertaining to the nature of reading traditional print texts. These models would serve as a reference point for an online reading model. In what follows, the terms "reading models", "models of reading comprehension" and "models of reading literacy" are used synonymously since reading always involves comprehension, understanding and interpretation. Actually, the term "reading literacy", which tends to replace the term "reading comprehension", refers to the simultaneous interaction of text decoding processes, processes of understanding and interpreting the text, reflection on the text, and its use in a variety of socio-cultural contexts (Piasecka, 2008).

2. Models of reading print texts

Models of reading comprehension developed so far have reflected the scholars' understanding of the reading process itself. Structural linguists who interpreted reading as "speech written down" (Silberstein, 1987, p. 28), were concerned mostly with associating sounds with letters, thus focusing on linguistic abilities and entirely disregarding thought processes (Piasecka, 2000). However, with the advent of cognitive psychology and generative linguistics, this approach has changed and thought processes were brought into focus along with linguistic processes.

2.1. L1 reading models

Cognitivists have adopted an information processing approach to learning, that is the reception, storage, integration, retrieval and use of information, based on the tripartite model of human memory. This approach is at the roots of the models of reading developed with respect to print texts. The models are classified into three categories, that is bottom-up, top-down and interactive. Reading processes included in the models are similar but they work differently (Rayner & Pollatsek, 1989).

Bottom-up, also called text-driven, models (eg., Gough, 1972) are concerned with processes that account for letter recognition in the readers' mind. Gough's model shows the processing in a very detailed way: it starts with eye-fixation on the visual representation of the sound, then moves from one memory store to another to arrive at the understanding of the sentence on the basis of syntactic and semantic rules. The model accounts mostly for letter recognition processes but is not concerned with higher-level comprehension processes.

Top-down (concept-driven, hypothesis-testing) models (eg., Goodman, 1967, 1988; Smith, 1978) show that due to the limited capacity of the visual processing system, the processing of the visual information may be slowed down by the so-called "bottlenecks". When such a situation occurs, the reader predicts what will come next, verifies it against the incoming information and accepts it, when it is correct or rejects it when the prediction is not confirmed. The predictions

are made on the basis of prior knowledge, both linguistic and general. However, this group of models was also criticised because the research on predictions and good readers shown that these readers do not make predictions on the basis of their linguistic knowledge but decode the text very fast due to automatic word recognition (Stanovich, 1980).

Neither bottom-up nor top-down models have accurately presented processes involved in reading. Reading was envisioned as a linear sequence of distinct stages in which information moves from lower to higher processing levels, however the movement in the opposite direction (from higher to lower levels) is not considered. This spurred the development of the interactive models in which information may flow from lower to higher and from higher to lower stages of processing, thus influencing the reader's visual perception.

Where is the interaction in interactive models of reading? First, it occurs when lower (decoding) and higher (comprehension) level processes come together to allow text comprehension (eg., Rumelhart, 1977). Second, linguistic knowledge interacts with general knowledge to bring about the understanding of the messages included in the text while eye fixations are controlled by the meaning the reader stores in working memory (Just & Carpenter, 1980). In Rayner and Pollatsek's model, foveal and parafoveal word processing is included and well as the component that is responsible for consistent understanding of the text. It controls eye movements and syntactic parsing when problems with understanding appear. Last but not least, there is Stanovich's (1980) interactive-compensatory model which applies both to skilled and unskilled readers. It is based on the premise that readers have some knowledge of spelling, vocabulary, syntax and semantics but these knowledge sources do not have to be equally strong. When a struggling reader has problems with word recognition but has some knowledge of the topic, they may make predictions about words and phrases on the basis of this knowledge. Thus various sources of knowledge, both linguistic and general, interact and support each other to compensate for inadequate knowledge in any of the systems.

Interactive models, then, combine both lower and higher level processes which support each other in text comprehension Reading always starts with the recognition of the scripted form that has to be lexically accessed and further processed to result in understanding. The models are based on the assumption "that skills at all levels are interactively available to process and interpret the text" (Grabe, 1988, p. 59). In addition, they are activated simultaneously, according to the processing needs of the readers.

At this point, it seems justified to devote some space to two terms that appear across the models, ie., decoding and comprehension. Decoding refers to the lower-level, or bottom-up processes such as word recognition, syntactic parsing, meaning proposition encoding and working memory activation. Word recognition, in turn, may follow either an orthographic path (a word is recognised letter-by-letter or

another graphic representation) or a phonological one when the reader knows the spoken form of the word, or both.

Higher-level, or top-down processes account for the construction of meaning that is based on a text model of reader comprehension, a situation model of reader interpretation, comprehension monitoring as well as attentional processes, goal setting, strategy use, and metacognitive and metalinguistic awareness. (Grabe, 2009). Text comprehension emerges from the interaction of these processes, the interaction of microstructure and macrostructure.

From the perspective of cognitive psychology, lower level processes account for the formulation of the so-called microstructure of the text. It is based on word meanings with the assigned syntactic roles that are used to build idea units called propositions which create a network of relations called the microstructure. The microstructure is the basis for building the macrostructure that reflects the global structure of the text, its topic or the "gist". Microstructure and macrostructure, also called the textbase, represent the literal, explicit meaning of the text, but not a more in-depth comprehension. This requires the reader to build a situation model of the text in which text information, prior knowledge and the reader's goals are integrated. (Kintsch & Van Dijk, 1978; Kintsch & Rawson, 2005). A situational model is not based on the verbal domain exclusively but also on "imagery, emotions, and personal experiences" (Kintsch & Rawson, 2005, p. 211).

Although comprehension processes are assumed to be the same across languages, there is much individual variation at the level of text comprehension that results from decoding speed and accuracy, semantic, syntactic and discourse knowledge, general knowledge, memory capacity and reading span.

Development of reading skills is associated with entering formal educational systems though the instances of young children learning to read on their own are not rare. Since reading abilities develop dynamically, readers encounter increasingly complex texts that require more advanced language along with general and specific knowledge to be comprehended. Thus, the present discussion focuses on educated learners of foreign languages of varying ages and abilities.

The models briefly sketched above refer to reading printed texts in the native language but they may also be adopted to foreign/second language reading. The most important characteristic of a foreign/second language reader is the fact that the person is at least bilingual and when starting to read in the foreign language, they may have already developed L1 literacy. In a bilingual mind the knowledge of two (or more languages) interacts and affects the ways in which a foreign text is processed and comprehended. Therefore, the next section presents models of foreign/second language reading.

2.2. Models of foreign/second language reading

Bernardt's model (1991, 2005, 2011) has evolved over the years and currently

it includes factors that are relevant to foreign/second language reading. Like Stanovich's, Bernhardt's model is interactive and compensatory. The following variables have been included into the model:

- L1 literacy (eg., the knowledge of alphabet, vocabulary, text structure, beliefs about word and sentence configuration).
- L2 knowledge (eg., morpho-syntactic and lexical knowledge, cognates, distance between L1 and L2).
- Unexplained variance (eg., comprehension strategies, content and domain knowledge, engagement, interest, motivation) (Bernhardt, 2011).

According to the model, L1 literacy explains about 20% of a reader's comprehension, L2 knowledge accounts for about 30% while unexplained variance accounts for the remaining 50% of text comprehension. The model was supported by several studies but a lot of variance was reported for L1 literacy and L2 knowledge (Brevik, Olsen & Hellekjær, 2016). In one of the studies L1 (English) literacy accounted for 10%–16%, and L2 (Spanish) knowledge for 30%–38% of the variance (Bernhardt & Kamil, 1995) while in another study L1 (Korean) literacy explained 3% and L2 (English) knowledge 57% of the variance (Lee & Schallert, 1997). Brevik et al. (2016) argue that this variability probably results from the distance or differences between L1 and L2.

Taking a cross-linguistic perspective, Koda (2005) argues that L2 sentence processing is affected by L1 morphosyntactic knowledge along with the L2 knowledge base, typological differences between L1 and L2 (orthographic distance, for example) as well as universal principles. In addition, she underscores the importance of background knowledge and domain-specific knowledge for text comprehension as they may compensate for limited L2 linguistic and rhetorical resources.

Piasecka (2008) proposed a model of L1 and L2 reading based on empirical findings of her study (see Fig. 1).

The knowledge of two languages is central to reading. Moreover, certain processes are the same in two languages and therefore the languages interact and slightly overlap. TCPF stands for Text Processing Conceptual Framework that is responsible for the recognition and interpretation of letters, words, and entire phrases in the reader's mind. The central element – knowledge of L1 and L2 (and also of other foreign languages, not included in the model) – is surrounded by another circle that represents individual learner differences, that is attitudes, language aptitude, dyslexia, reading practices and reading preferences. This circle is embedded in yet another circle that represents the reader's social context including the family socio-economic status, literacy leisure activities, school success, print-rich environment and access to the Internet (*sic!)*. Possibly, the environment-related factors identified by Piasecka may be assigned to Bernhardt's unexplained variance group. The multiplicity of factors and their configurations imply how complex the process of L2 reading is.

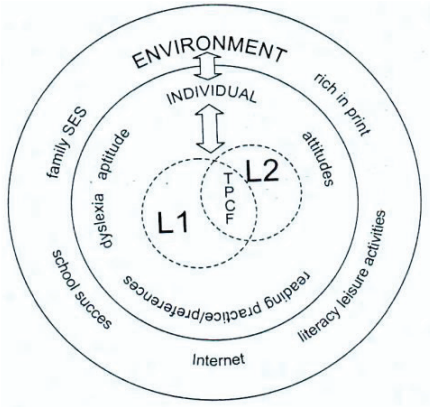

Figure 1. A model of L1 and L2 reading – an interplay of psycholinguistic and sociocultural factors (Piasecka, 2008, p. 187)

L1 literate L2/FL learners, both educated adolescents and adults, are usually familiar with the alphabet, they are aware of what words and longer utterances are made of, they are able to recognise a range of text types, they usually engage in some literacy practices. While they may not experience serious problems on the level of letter recognition, they may stumble on lexical access, ie., they may not be familiar with vocabulary and/or grammatical structures and forms used in the text. This may lead to further problems with text processing and discourage and demotivate learners from reading. Therefore it is extremely important to help them develop reading skills and strategies. New technologies and the Internet may become quite helpful in this respect. The following section addresses online reading models in L1 and L2.

3. Online reading model(s)

According to Internet Users Statistics (https://www.internetworldstats.com/stats.htm), there were 4,383,810,342 Internet users worldwide on March 31st, 2019, which is 56.8 % of the world population (7,716,223,209). This is an impressive number and it is going to increase. Leu, Kinzer, Coiro, Castek, and Henry (2013, p. 1159) observe:

> Never in the history of civilization have we seen a new technology adopted by so many, in so many different places, in such a short period of time, with such powerful consequences for both literacy and life.

Advances in new technologies result in new text forms that require new ways of processing and, consequently, new literacies (Leu, 2000). The literacies connected with ICTs change very quickly so they have been termed "deictic" (Leu et al., 2013, p. 1150) because new literacies are new today but tomorrow

there will be other new literacies. In such a situation it is extremely challenging to "develop adequate theory when the object that we seek to study is itself ephemeral, continuously being redefined by a changing context" (Leu et al., 2013, p. 1151).

As signalled in the Introduction, researchers (Coiro, 2003; Coiro & Dobler, 2007; Piasecka, 2012, 2013; Murray & McPherson, 2006) find similarities between online and offline text comprehension, especially when processing verbal messages is considered. However, Internet users also have access to multimodal information formats that accompany verbal information and require additional processing that involves new online reading comprehension skills. Members of the New Literacies Research Lab suggest that the following online reading comprehension skills are necessary: "(1) identifying important questions; (2) locating information; (3) analyzing information; (4) synthesizing information; and (5) communicating information" (Mokhtari, Kymes & Edwards, 2008, pp. 354–355). In a way, these skills are similar to offline skills but in the Internet environmet the reader has to quickly process much more information than in a classical library with printed books that were reviewed, revised, and selected on the basis of certain criteria, and catalogues that group books in various ways so the preselection of resources has already been done for the reader. Moreover, navigating online texts differs from leafing book pages as it is more demanding to return to the same passage online unless it has been highlighted.

Reading online to find answers to the important questions that the reader has formulated involves the necessity to individually locate and select relevant information. Since the Internet is an open resource where everybody may publish what they want, the reader has to develop the skill of finding reliable information effectively. Addressing this issue, Henry (2006, p. 617) has proposed a set of basic search skills that are represented by the SEARCH acronym:

1. **S**et a purpose for searching.
2. **E**mploy effective search strategies.
3. **A**nalyze search-engine results.
4. **R**ead critically and synthesize information.
5. **C**ite your sources.
6. **H**ow successful was your search?

When the information has been located, selected and assessed for appropriacy and quality, the readers need to comprehend both the language with its nuances as well as the visual and acoustic clues. They have to be ready to cope with the content in a non-linear fashion, being aware of the distractors in the form of the hyperlinks, popping-up ads in the background, and others. Most important, they "need a critical awareness of the semiotics of language, (i.e., language as design), which is essential to the critical understanding of the composition and production

of digital texts" (Rowsell & Burke, 2009, p. 117).

Despite the fact that new/online literacy is such a complex and dynamic phenomenon, an attempt has been made to build a componential-interactive process model of online text comprehension. It combines the elements of print reading models with the empirical findings and theoretical considerations with respect to online reading.

Online reading involves the following non-linear processes that interact to bring about comprehension of online text that differs qualitatively from print texts (cf. Coiro, 2003, Introduction to this paper). The quotations in the brackets refer to the online reading skills discussed above (Mokhtari et al., 2008):

- setting a goal of reading ("identifying important questions");
- effective searching of information online
- analysing web-search results } ("locating information")
- selecting relevant information (in terms of the goal, with the support of prior knowledge)
- reading it critically (using lower and higher level processes, evaluating its relevance to the goal)
- synthesizing information from multiple sources ("synthesizing information")
- communicating information in various modes and to various individuals or groups ("communicating information")

Processes of print and online Internet text reading have been compared to show the degree of overlap between them as well as the factors that make reading in these two conditions distinct. Figure 2 shows the results of the comparison.

The figure clearly illustrates that there is a substantial overlap between the two modes of reading yet the differences also appear. They refer to the types of texts processed, to finding relevant and reliable information as well as to the idea of sharing information that is inseparable from using the Internet. Present day reading has been gradually losing its private character and becomes more and more a group activity

Another important characteristic of the comparison is the interdependence between print and online reading that has been empirically supported. Coiro (2011) carried out a study of offline and online reading comprehension and found out that offline reading accounted for 35.1% of the variance in online reading comprehension while prior knowledge explained only 7.1 % variance and its effects were statistcally significant for low performing readers. The findings of the study suggest that some of the online comprehension skills are similar to offline comprehension skills but others are unique to online comprehension and reflect its complexity.

The picture of online reading comprehension becomes even more complex when reading online in L2 is considered. The major difference be-

tween L1 and L2 online reading comprehension rests in the L2 proficiency and literacy level which account for breaking the

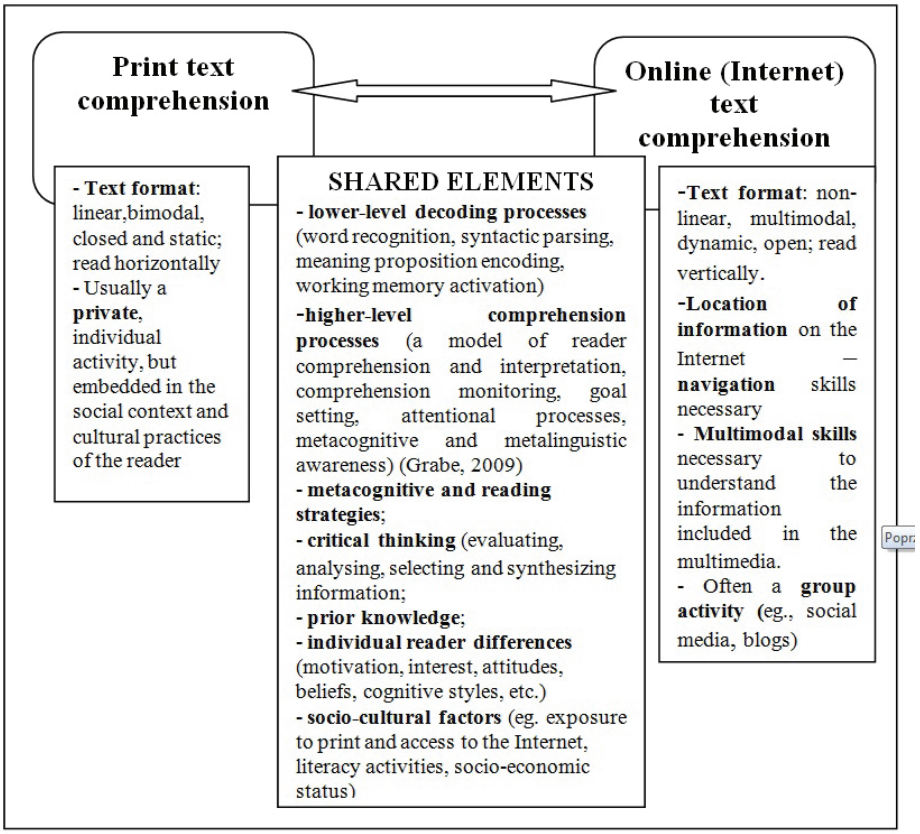

Figure 2. Comparison of print and online (Internet) text comprehension.

linguistic code and extracting meaning from the text. For this reason, L2 readers may rely more heavily on prior knowledge and predicting strategies when they encounter problems with comprehension. Since the carryover of L1 search and navigation skills is more than likely, L2 online readers have to become familiar with L2 online text conventions if and when such appear. With a goal of reading set, they may search for information effectively, critically analyse and read the search results in order to synthesize and communicate the results, if need be.

A model of L1 and L2 online reading comprehension is presented in Fig. 3. It synthesizes Piasecka's 2008 model and the comparison of print and online reading comprehension in terms of one or more languages.

In the model, the factors contributing to text comprehension have been placed against the backdrop of individual and socio-cultural factors that account for

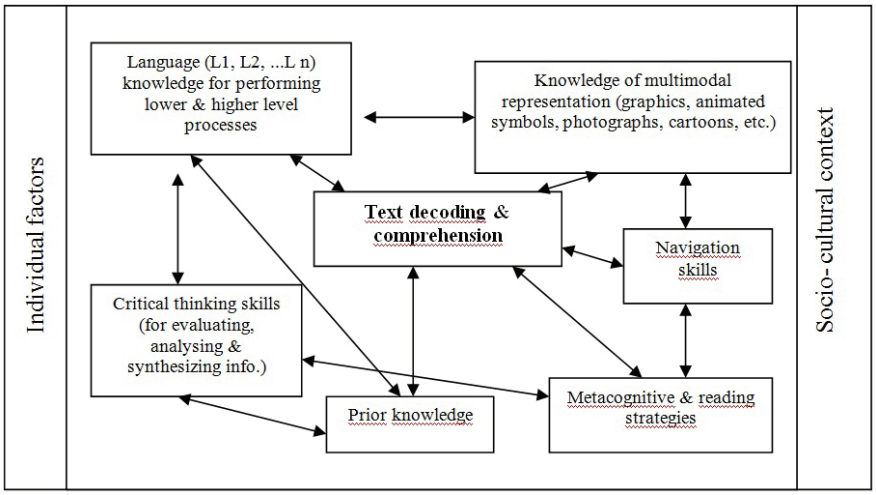

Figure 3. A model of online L1 and L2 reading comprehension

differences in reading performance. Thus, comprehension of an online L2 text is based on the knowledge of two or more languages that interact in the reader's mind in a dynamic manner and allow them to use all the linguistic resources they have access to. It also involves the reader's familiarity with multimedia that carry non-verbal meanings (cf. Coiro, 2003, the Introduction to this paper) that contribute to (or disturb) verbal messages. Another new element in the model refers to navigation skills that allow the reader to consult a number of internet resources to find information necessary to comprehend the text (eg., online dictionaries animations, slide shows, video clips, etc.). Metacognitive and reading strategies combine print and digital reading strategies and also include goal setting as a metacognitive strategy. Prior knowledge supports comprehension and may compensate for gaps in language knowledge. Critical thinking skills are indispensable for building a situational model of text comprehension, for an in-depth analysis of the information as well as for integrating information from multiple sources. The arrows indicate dynamic relations among the factors that operate within other dynamic systems of individual differences, social contexts and cultural heritage.

Working on L2 Internet texts is beneficial for foreign/second language learners because they handle texts that are authentic, they may choose the ones that match their interests, their comprehension may be supported by multimodal text elements. In addition, successful reading of self-selected texts, for example, may motivate the readers to read more. Japanese university students have been reported to prefer reading screen-based over paper based books (Walker, 2016). When learners read more, they develop the skills and strategies indispensable for effective online reading.

4. Conclusions

The Internet is present in many spheres of contemporary life and over a half of the world's population use it for a variety of reasons and purposes. To benefit from the resources available on the Internet, its users need a repertoire of online reading skills and strategies, included in the proposed model of online reading comprehension, which should become an integral part of school curricula at different levels of education. Moreover, these new literacy skills should not be taught and practised in isolation but in the context of various school subjects.

The proposed model combines print-related components with skills that refer exclusively to the online environment such as navigation skills and an ability to make sense of multimodal text elements. Moreover, it can apply to reading in one's native language as well as to reading in other languages that the reader is familiar with. Yet, crucial to all reading is the knowledge of the language which cannot be replaced even by very sophisticated multimedia.

The features of online texts, however, may have both a positive or a negative effect on comprehension. It has been shown that the colour of font and of the background influence decoding, for example blue text has a negative effect on readability (Nielsen, 1999). On the other hand, when the reader has used the link and its color changed to purple, it has a positive effect on readability because the readers know which spaces of the hypertextual setting they have visited. Readability is also enhanced when texts are lexically dense but include nominalizations and information which is organized into chunks by means of lists, boxes or short paragraphs. In addition, objective language, headings and bold or coloured key words have been found to contribute to higher readability.

Interestingly, though the readers prefer to scroll the text vertically rather than horizontally, vertical scrolling makes them feel disoriented and lost. Readers' feelings of disorientation and confusion may increase due to poor and chaotic design of Web pages. Checking the links in the hypertext, evaluating them, making navigational choices and processing many fast sensory stimuli they may experience information overload that may bring about distraction from the purpose of reading and, consequently, further confusion (Murray & McPherson, 2006; Usó-Juan & Ruiz-Madrid, 2009; Carr, 2010). Moreover, such factors as screen resolution and screen glare result in eyestrain, which also accounts for difficulties in digital reading (Morrison in Usó-Juan & Ruiz-Madrid, 2009). In addition, hypertexts displayed on the computer screen may distract the reader's attention because of popping up adds, hyperlinks, the blinking screen, and so on.

There is also a danger connected with fast processing of online information. Internet users can locate short pieces of information, usually the size of the computer screen, and make connections between and among them, but they have problems focusing on longer texts. They may loose "the literary mind-set" (Tucker, 2010, p. 61) that requires patience, concentration and engagement with the text.

Recently, Internet users coined an acronym "TL;DR" which means "too long; didn't read" (Dukaj, 2010). This kind of response may result from information overload and the lack of time to read carefully what the user wants to read and what other users think this user may wish to read.

However, over five hundred years of printed books and other documents cannot and should not be ignored – a history of books is also a history of progress and development of human civilization. Reading printed matter, people have developed literate minds along with a wide range of meaning making skills and strategies that may also serve them well in the online environment. Actually, readers frequently switch between print and screen presentations of written language and this way they do not turn into mere text decoders. They also have a possibility to develop a deeper insight into the texts and their meanings.

Print and screen texts as well as skills and reading dispositions do not exclude but support and complement each other as shown by the following quotation:

> In the transmission of knowledge the children and teachers of the future should not be faced with the choice between books and screens, between newspapers and capsuled versions of the news on the Internet, or between print and other media. Our transition generation has an opportunity, if we seize it, to pause and use our most reflective capacities, to use everything at our disposal to prepare for the formation of what will come next (Wolf, 2008, p. 228).

N.B. When I was working on this text, I used both printed and Internet resources, switching between them as the need arose. And I enjoyed it!

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