Digital Information Literacy: Challenges and Opportunities for 21st Century Education

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Abstract

An increasing number of everyday activities require the use of electronic information devices such as desktop computers, tablets or smartphones. However, early access and exposure to these devices is far from enough to shape a generation of "digital natives". Instead, there is mounting evidence that in order to effectively participate in digital communities, people must acquire a range of advanced literacy skills. These new demands and new skills question traditional views of reading and reading education. In this paper, I introduce a theoretical framework that describes the core skills involved in accessing, evaluating and integrating digital information. I present a series of recent observational and intervention studies that point out some of the difficulties faced by children and teenagers when purposefully using online information systems. I suggest some possible strategies for education systems to implement effective digital literacy training programs at the level of primary, secondary and post-secondary education.

Introduction

This paper seeks to contribute to the aims of the conference through an analysis of the quality of education in the key domain of reading literacy. I focus on the new opportunities and challenges that come with the spread of information and communication technology (ICT) in and out of school. After a short introduction on the status of reading in the so-called "information society", I outline a recent model of reading literacy that applies to a wide range of reading situations, both in traditional and electronic media. Then I review a few recent studies that aimed at understanding the complexities of functional reading and to design effective interventions at primary and secondary educational levels.

For about three decades, the use of electronic information and communication devices has been steadily increasing in most parts of the World. From less than 10% at the beginning of the 21st Century, the percentage of households equipped with microcomputers and a connection to the Internet had reached an average of about 70% in the OECD countries ten years later (OECD, 2011). People and organizations rely more and more on the electronic

production, storage and transfer of electronic information. Whether for personal, professional or civic purposes, an increasing number of everyday activities make use of electronic information devices such as desktop computers, tablets or smartphones.

The consequences of the information society for education and training are still debated. While some believe that new generations of "digital natives" would spontaneously arise as a consequence of early exposure and immersion in technology (Prensky, 2001), others have pointed out that the skilled use of information systems may entail some complexities for children and teenagers, and thus pose new challenges for educational systems. Be as it may, it is widely acknowledged that education systems need to adjust to new communication and information practices by implementing adequate teaching and evaluation procedures. The exact nature of these procedures, however, remains to be elicited.

In this paper, I attempt to contribute to this discussion by emphasizing some of the advanced literacy skills that are required for people to effectively participate in digital communities. I will especially focus on advanced reading and text comprehension skills, which some have deemed less critical based on the claim that most information conveyed online is multimodal and makes use of pictorial rather than verbal information. After a short discussion of the changing status and definition of reading ability in the digital world, I introduce a theoretical framework that describes the core skills involved in accessing, evaluating and integrating digital information. I review a series of recent observational studies that point out some of the difficulties faced by children and teenagers when purposefully using online information systems. I describe some current efforts to design and implement effective reading comprehension interventions based on the use of computer-based training modules. Finally, I suggest some possible strategies for education systems to foster digital literacy acquisition at primary, secondary and post-secondary education levels.

The status of reading in the information society

The advent of microcomputers, the Internet and mobile communication devices has deeply transformed the way people perform a large number of their everyday personal, social or other types of activities. Examples include communicating with relatives and friends, shopping, interacting with businesses and administrations, or entertaining children with adequate songs, stories or games. While access to ICT is generally perceived as contributing to people's connectivity, autonomy and empowerment, skilled Internet use is far from a given to laypersons. In a survey conducted in the early 2000s with a panel of 100 French families from a small urban community (Rouet, 2005), it was found that novice internet users were excited - but also often challenged - by new possibilities such as receiving and sending pictures together with email messages, getting information about objects or topics of interest (some quite popular such as the weather or transportation schedules, others more peculiar such as car maker logotypes). The study also observed that Internet users' vocabulary and ability to perform basic routines continued to develop over the first two years of experience (Rouet, Jégou, Metta, & Limam, 2004). Some essential activities such as locating specific pieces of information on the Web, installing a new printer or dealing with viruses remained nontrivial for many people.

What are the skills required to become a proficient user of the Internet? Clearly a fair deal of knowledge and know-how regarding information and communication technology is needed. Then, depending on the type of activity, using ICT and the Internet may call upon social skills, reasoning ability, or even math or specialized topic knowledge (Griffin et al., 2012). However, the one single ability common to each and every use of the Internet is the ability to read and make sense of written language. This may not seem obvious at a first glance, because our stereotypes about computers and the Internet are more often associated with pictures and multimedia information. However a closer look at what it takes to access relevant services and content makes it clear that the printed word is always needed at some

point in the process. Maybe the most revealing illustration of this fact is that the use of an Internet browser usually begins by either clicking on a bookmark or typing a few keywords in a search engine -- both requiring the reading and in the latter case the writing of linguistic information.

One may even consider the possibility that the advent of the Internet is placing an even greater emphasis on one's mastery of written language, among other higher-order cognitive skills (Griffin et al., 2012). Among the general public's favorite Internet uses are exchanging email and searching for information (Pew, 2005; Rouet, 2005). Before the Internet, people would generally use the telephone or face-to-face communication to perform the corresponding activities. For instance, they would call a train or airline company operator to find out about travel schedules. Wherever Internet access is widely available, there are numerous examples of activities in which speech is being progressively replaced with print-based, email or short message communication.

This view contrasts with the belief that the practice of reading may be decaying in developed societies, especially among the youth, to the benefit of other activities such as watching television or videogaming. Indeed, in the case of France national surveys show a small but steady decline in the reading of books over the past 30 years (Ministry of culture and communication, 1973-2008). The decline, however, is true at all ages and is much sharper among intensive readers (i.e., those who say they read 20 books or more per year). Occasional readers to not seem to read much less than they used to do a few decades ago. Furthermore, according to sociological studies, teenagers report reading almost as much as they would have 10 or 20 years before (Baudelot, Cartier, & Détrez, 1999). Finally, the number of new books published per year seems more or less stable, with books for the youth, comics and mangas representing a fair proportion of the total number of copies sold per year (for French statistics, see Ministry of culture and communication, 2011). In brief, there is no evidence that the

practice of reading traditional materials such as novels or magazines may be close to extinction. If one consider the new forms of reading that come with ICT use, it may be conjectured that people spend more time reading today than they have ever done, though the nature of reading may be undergoing some important changes.

These figures should not overshadow the existence of sharp differences within the general population. The latest edition of the OECD-PISA survey has confirmed that the distribution of reading skills among 15 year-old students is extremely widespread (OECD-PISA, 2010). In some countries (such as France), the gap between the highly skilled and the less skilled has widened in comparison to previous surveys. According to the French National Agency Against Illiteracy (ANLCI, 2010) 9% of the French population between the ages of 18 and 65 are "illiterate", a term meant to describe those people who have attended school but cannot make use of printed artifacts to achieve simple practical goals such as writing a check or reading a sign on the street. Even though the figures tend to increase with age, 4.5% of the people aged 18 to 25 (i.e., close to 300,000 young adults) are considered illiterate. Among those who can make use of print, the amount of print-related activities is positively correlated with socio-economic and cultural status (Ministry of culture and communication, 2008). At the worldwide level, the literacy rate defined as "the percentage of the population of ages 15 and older who can, with understanding, both read and write a short simple statement on their everyday life" is estimated to be 81%, a figure that drops down to 59% in the least developed countries (United Nations Development Program, 2011).

In summary, reading ability continues to play an essential and perhaps even increasing role in people's ability to effectively participate in post-industrial societies. The practice of reading in the traditional sense (i.e., printed books) is slightly decreasing, but this decrease is compensated by the amount of reading people have to perform in order to make use of digital media. However, there is a wide distribution of skills among teenagers, and the existence of a

large percentage of students who are not able to perform simple comprehension tasks is a deep concern given the critical role of reading skills.

A comprehensive framework for reading literacy

The pervasiveness and distinctiveness of reading as part of digital media use questions the adequacy of current definitions of reading ability. In the popular wisdom as well as in educational practice, reading often remains associated with the printed book, and the stereotype of the literate reader is often that of a person deeply engaged in the sustained reading of a novel or an essay. This traditional definition of reading has contributed to shaping the most widely accepted definition of reading ability, in which knowing how to read means both being able to decode written words and to comprehend the meaning of sentences and text passages. This definition is often called the "simple view" of reading (Hoover & Gough, 1990) and emphasizes the importance of core processes in reading acquisition and instruction. Decoding and comprehension are seen as distinct but related skills, which contribute equally the reading proficiency. Whereas decoding is obviously specific to reading, comprehension is often seen as a more general ability, underlying both spoken and written communication. Comprehension entails several components or "aspects", from the location of simple facts to the integration of ideas into a gist representation to the production of various types of inferences (Kintsch, 1998; OECD, 2008). As evidenced in a large number of studies, the conception of reading as decoding + comprehension explains many of the difficulties faced by students when learning how to read during the first years of their formal education. The lack of sufficient decoding skills creates a "bottleneck" which prevents readers from devoting enough resources to comprehension (Perfetti, 1985). Good decoding skills, however, are a necessary but not sufficient condition for proficient reading. Readers must also be able to perform the higher-order cognitive processes required to achieve comprehension, i.e., the construction of a mental representation of what the text is about (Kintsch, 1998).

However, people's reading experiences are obviously more pervasive and diverse than the mere reading of novels and other continuous texts. For instance, people read messages and technical documents for their work; they read instructions and forms to interact with administrations and services; they read leaflets, labels and other types of documents to shop, travel and perform many others (actually most) mundane activities. In fact, it is likely that most of the reading that takes place daily in the developed world is the reading of nonfiction, functional materials. Some of it may be seen as trivial (e.g., reading the price of an item on a label at the supermarket), some of it involves far more complex pieces of information and sophisticated strategies. This is particularly the case of digital reading, when people quickly go through a large number of pages containing continuous texts but also hyperlinks, menus, tables and other types of information. The view of reading as decoding plus comprehension then appears somewhat restrictive. Broader frameworks such as the OECD-PISA reading literacy framework (OECD, 2008) acknowledge that reading literacy includes the ability to comprehend non-continuous as well as continuous texts, and considers aspects such as "access to content information" or "reflection from the text" to be part of skilled reading on top of comprehension in the traditional sense. Moreover, the OECD-PISA 2009 survey, which included for the first time an "electronic reading assessment" in complement of the print reading assessment, has found that electronic reading entails some specific subskills as evidenced by the fact that the correlations between print and electronic reading is no higher than that of reading and the other major domains of PISA (OECD, 2011).

The growing awareness of the diversity of reading acts has triggered new efforts to define the core processes involved in skilled reading at a theoretical level. One of the recent outcomes of these efforts is the MD-TRACE model (Rouet & Britt, 2011), which aims to describe reading skills in a broad sense, especially when applied to complex or multiples

pieces of text. Just like other frameworks, MD-TRACE is anchored in the more general theories and concepts of human cognition, language and memory (see, e.g., Kintsch, 1998).

The MD-TRACE model considers that contextual dimensions play a critical role in shaping readers' actual behavior (Rouet & Vidal-Abarca, 2002; Snow and the RAND reading study group, 2002). As noted by Snow et al. (2002) "Reading does not take place in a vacuum. It is done for a purpose, to achieve some end." (p. 15). Snow et al. suggest that the broader sociocultural context in which reading takes places contributes to shaping the purposes, processes and consequences associated with reading. Thus, given a particular reader and a particular text, many different reading behaviors may be observed as a function of when, where and why the reading episode is taking place. Thus, in order to understand how reading works, we need to understand how readers interpret the explicit and implicit demands of the context. McCrudden and Schraw (2007) expressed a similar view by establishing a distinction between text-based importance, on the one hand, and relevance (or task-based importance) on the other hand. Text-based importance is the degree to which a text segment includes information needed to understand the text (or structural importance), whereas relevance is the extent to which a segment contains information that is necessary to perform a certain task (e.g., to answer a question). They pointed out that in most situations, readers approach the text with more or less specific goals or objectives that may affect the relevance of textual information irrespective of its structural importance. Accordingly, the MD-TRACE model acknowledges that reading is a purposeful situation in which the reader attempts to fulfill the demands of a task.

The MD-TRACE model describes reading as an unfolding cycle of five core processing steps and decisions (see Rouet & Britt, 2011, for a more detailed description). Each step is supposed to bring to bear specific pieces of knowledge and, sometimes, specific subskills.

Step 1. Create and update a task model. In Step 1, the reader constructs a representation of the task or purpose at hand. This may be done based on either explicit requirements (such as an assignment received from a teacher) or based on self-generated goals, sometimes as part of a broader activity. The task model may include a representation of the information to be acquired and the format of the anticipated outcome, solution or response to the task.

Step 2. Assess information needs. In Step 2, the reader decides whether the fulfillment of the task requires the use of an external information resource, for instance a text. This decision may be based on the reader's assessment of her existing knowledge, and on practical issues such as time available or easiness of access (think for instance, of situations where a person may ask "Do I need to fetch my laptop, launch my browser and search for information, or can I just guess which is the best course of action?"). One's assessment of information needs is not in itself specific to reading. However the specificity of reading devices and materials combined with one's perception of their own proficiency at reading may influence the person's decision to opt for reading as opposed to other tactics to complete the task at hand.

Step 3a. Assess item relevance. Step 3a is when actual reading starts taking place. Readers access texts of interest through many different devices such as book covers, tables of contents, indexes, search engines or hyperlinks and so forth. They may also directly browse the contents of an extended passage of text until they reach the passage of interest. The point here is that appropriate texts are not always readily available to the reader. Instead, readers often need to evaluate texts for topical relevance (it the text related to the task?) and for other parameters such as accuracy, usefulness, trustworthiness and so forth. They may skip irrelevant entries or passages, and focus on relevant ones. These processes are specific to reading in that they are based on the reader's awareness and processing of linguistic features

such as author information, date and place of publication, intended audiences, etc. that are represented in front and back cover materials, credits, and other devices specific to printed artifacts (both on paper or digital).

Step 3b. Process text contents. Once a passage of interest has been found, the reader may process it in order to acquire a detailed understanding of the contents. This is the step where comprehension in the traditional sense takes places. Note, however, that readers will often alternate between phases of quick scanning and phases of slower, deeper processing of the materials as a function of the specificity of their task. The degree to which readers will actually understand the meaning of the passage depends on their comprehension skills (Kintsch, 1998) and on the amount of prior knowledge they possess on the topic.

Step 3c. Create/update a Documents Model. In this step readers may consider drawing relationships between several passages of texts. This if often the case when students make use of multiple documents in order to study a topic of interest. The documents may be related in several ways. They may add or provide support to each other, but they may also in some case oppose or contradict each other. As proposed in the "documents model" theory by Perfetti, Rouet and Britt (1999), readers have to be able to draw these connections in order to understand how each text contributes to the topic or issue at stake. These high-level, intertextual relationships are seldom considered in current instructional and evaluation practice. Nevertheless, they play an increasingly important part as the amount of information accessible on any topic continues to increase thanks to the Web and other resources available to people.

Step 4. Create/update a task product. In Step 4, the reader makes use of document information to construct a response to the task. At this stage, the reader needs to take into account the initial task specifications, the type of response or product that is expected (see Step 1), and the information acquired from the texts (steps 3a to 3c). In some contexts the link

between task and texts is straightforward and the reader merely extracts information from the texts in order to address the task. In other cases, however, the reader needs to transform source information in order to generate a solution. In most real-life situations such as document-based essay writing, readers will start producing notes and drafts as they go through the available information sources. Step 4 captures a key feature of authentic purposeful reading, i;e., the fact that it is often intimately associated with writing.

Step 5. Assess whether the product meets the task goals. Step 5 is when the reader decides whether she has fulfilled the task to a sufficient level or whether she needs to recycle through earlier steps. If the task product (Step 4) is deemed satisfactory, the reader may terminate the process. If not, the reader may need to recycle through one of the earlier stages. In the simplest case, the reader will complete or revise his or her product in order to improve it (Step 4). If the reader can't think of an obvious improvement of the task product, he or she may need to reassess their information needs (Step 2), and possibly proceed to select a new document or to re-read a previously read document (Steps 3a or 3b).

Decisions to recycle through earlier problem-solving stages typically belong to the realm of self-regulation, a complex compound skills that rests in part on higher-order memory processes that develop late during childhood and adolescence (Greene & Azevedo, 2007). Teenage students' limited self-regulation ability is a factor to consider when assigning complex document-based reading activities, whether in print or online.

In summary, the MD-TRACE model of reading literacy emphasizes key processes of expert reading that take place before, during and after a person has actually engaged with a text. We believe that these processes complement the traditional view of reading as decoding plus comprehension. Failure to apply these processes may explain children and teenagers failure in functional reading tasks such as, for instance, the OECD-PISA assessment tasks. In the next section I will briefly review a few studies documenting students' difficulties with

some of these processes and also innovative interventions that may foster students functional reading literacy in the sense of the MD-TRACE model.

Obstacles to reading literacy and promising intervention procedures

Models such as MD-TRACE are helpful in that they elicit potential sources of difficulties for experienced but non-expert readers, such as secondary education students. In a series of recent studies, we have found that students between the ages of 9 and 13 often had trouble selecting relevant items in tables of contents or search engine results pages (Rouet & Coutelet, 2008; Rouet, Ros, Goumi, Macedo-Rouet & Dinet, 2011). This seems to be due both to their lack of awareness of content access devices, and to their reliance on surface relevance cues such as perceptual salience or matching keywords, as opposed to deeper semantic links. We have also observed that primary school children possess little awareness of the features of information sources such as an author's expertise (Macedo-Rouet, Braasch, Britt, & Rouet, under review). These studies indicate that there is ample room for interventions targeting advanced reading literacy skills at the primary and secondary levels of education.

In recent years, cognitive and instructional scientists have undertaken to develop training programs aimed at improving children and teenagers' ability to deal with purposeful reading assignments. Among the promising projects are the Sourcer's Apprentice by Britt and colleagues (Britt & Aglinskas, 2002); the Tuinlec program by Vidal-Abarca and colleagues (Gil et al., 2012; see also Vidal-Abarca, Mañá, & Gil, 2010); the IStart project by McManara and colleagues (McNamara et al., 2007), or the LIRALEC program by Rouet and colleagues (Rouet & Goumi, 2010). These programs have been or are currently being tested in panels of classroom, with sometimes quite dramatic effects on students' achievement levels. One

obstacle however, is to ensure that the programs can be easily transferred so as to be successfully implemented by teams of teachers without the support of the research teams.

Conclusions

A discussion on innovative interventions aimed at promoting reading literacy has to take into account the increasing diversity in the types and uses of print in post-modern society. Firstly, in most countries of the world, printed materials are increasingly being used for educational, professional, civic and personal purposes. An ability to read and comprehend written language is more than ever a condition of employment and participation in society. Secondly, digital media have brought dramatic changes in the processes used to produce and disseminate written materials. Websites, forums, blogs and short message systems, which were unknown of the general public just a few years ago, are now part of the average teenager's daily life. These new forms of textuality are not just for leisure, they tend to pervade all aspects of human communication including the most serious ones.

There has been a heated debate over the consequences of these dramatic changes for young readers' literacy education. Some have claimed that the upcoming generation of "digital natives" would readily benefit from these new forms of communication, whereas others fear that digital media such as short messages systems are threatening students' language skills. In fact, research suggests that new forms of text-based communication may both represent new challenges and opportunities. On the one hand, reading in today's world is no easier than it was in the era of paper books. Instead, the increased diversity and complexity of texts imposes new demands on the reader. Skilled readers have to be able to access, to assess relevance and trustworthiness and to integrate information from multiple sources (Rouet, 2006). Experiments suggest that an awareness of the features of various types of texts is a condition for skilled access to and comprehension of text information. On the other hand, new forms of written communication such as short messages do not seem to harm students'

mastery of traditional writing styles. Instead, they contribute to the emergence of new registers of communication that may be seen as a source of empowerment for those that can use them effectively.

A challenge for education is the seemingly increasing gap in the status of reading instruction in primary education and the practice of complex forms of reading in secondary schools and in society at large. There is a need to foster advanced reading and information strategies in teenagers, so that they can effectively engage in and enjoy all forms of reading. Second, it is important to update our definitions of reading in order to keep up with the innovative reading culture among the youth. New forms of author-based and interactive written communication need to be nurtured and educated just as the more traditional forms of book reading.

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