

UNIVERSITY LEVEL SECOND LANGUAGE READERS' ONLINE READING AND COMPREHENSION STRATEGIES

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With the growing prevalence of Web 2.0 technologies and use of online resources in their classrooms, language learners have increasing exposure to online texts. In this study we attempted to understand how university level second language (L2) readers construct meaning when reading online. We investigated L2 readers' information-seeking strategies and decision-making processes as they read online. Seven participants were asked to read two online texts and answer comprehension questions. Observation, think-aloud protocols, and interviews were our main sources of data. Through careful thematic coding analysis, we were able to characterize L2 readers' processes of constructing meaning while reading online using Internet resources. The findings indicate that L2 readers employ considerable prior knowledge of the structure of both offline and online resources to aid their online reading. Also, they follow a recursive pattern of self-regulated reading strategies when they construct meanings. Some themes highlighted by the study include L2 readers' online knowledge construction, their demonstration of cognitive flexibility, and the emergence of new literacy skills.

Keywords: Reading, Literacy, Language Learning Strategies

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INTRODUCTION

As the most broadly used technology for information gathering, the Internet has become one of the most important contexts for education. Over 2.9 billion individuals use the Internet (World Wide Web Consortium, 2014), and as the number of users of the Internet has increased, literacy practices, particularly in the area of reading (Coiro, 2011), have changed in response to the challenges and resources of the new media. Past studies have shown that proficient first language (L1) speakers use a variety of reading strategies to construct meaning (Langer, Bartolome, Vasquez, & Lucas, 1990; Pressley & Afflerbach, 1995), while more recent studies have determined that online reading requires comprehension “practices, skills, and dispositions” (Castek, Coiro, Hartman, Henry, Leu, & Zawilinski, 2007, p. 38) that go beyond what traditional reading comprehension strategies can inform (Castek et al., 2007; Leu, McVerry, O’Byrne, Kiili, Zawilinski, Everett-Cacopardo, . . . Forzani, 2011; Coiro, 2003, Coiro & Dobler, 2007; Hartman, Morsink, & Zheng, 2010). To become successful readers in the digital age, readers need both traditional reading strategies and new skills associated with reading online texts (Afflerbach & Cho, 2009; Coiro & Dobler, 2007).

Online reading has become a major source of input for ESL/EFL learners in that the Internet provides diverse reading materials with the advantage of instant access to a variety of support resources that can facilitate reading comprehension. Previous research has explored online reading strategies of L1 speakers of English (Coiro & Dobler, 2007; Coiro, Knobel, Lankshear, & Leu, 2008; Leu et al., 2007; Leu, Kinzer, Coiro, & Cammack, 2004) and L2 speakers of German (Lück, 2008), French (Barrière & Duquette, 2002),

and English (Kol & Scholnik, 2000; Lin & Chen, 2007; Mokhtari & Richard, 2004). However, more research is needed to understand L2 readers' strategy use for online texts. In order to develop L2 online readers who can use multiple ways of understanding online texts, there is a pressing need to understand L2 users' online reading strategies and their resource use. A growing body of research has begun to explore ESL/EFL online readers' patterns (Akyel & Erçetin, 2009;; Chun, 2001; Konish, 2003; Park & Kim, 2011). Nevertheless, in a review of research on L2 online reading, Chun (2011) pointed out that there is a lack of research that investigates how computer software might help activate L2 readers' background knowledge and called for more research on the role of knowledge of text structures and of discourse organization. This study is an answer to her call in that we have explored how seven advanced online readers employ online reading strategies in order to comprehend non-linear online texts, such as blog postings and news articles.

THEORETICAL FRAMEWORK

Reading as a Meaning Construction Process

Reading is considered to be a process of active meaning construction (Beach, 1993; Langer, Bartolome, Vasquez, & Lucas, 1990; NICHD, 2000). In this process, readers make use of both linguistic information from the external printed text (Langer et al., 1990) as well as their own internal background knowledge (Coiro & Dobler, 2007). In the Internet space, the external text may include multiple modalities of knowledge representation such as texts, graphics, video clips and audio resources. As an analytical framework for investigating the external and personal resources ESL learners use to support their online reading comprehension in this complex environment, we applied the notion of reading as a meaning construction process to non-linear online reading, in which the text does not follow a fixed sequence but ones in which the text might be embedded in links or presented in varied modalities.

Self-regulated Reading Strategies

The term "self-regulated" has been used to describe learners who learn strategically with metacognitive awareness of their own learning (Winne & Perry, 2000; Zimmerman, 1990). Hacker (1998) proposed the notion of self-regulated reading to elucidate readers' evaluative and repairing processes in reading. Skilled readers regulate their reading by using and evaluating strategies to increase their reading efficiency in printed text (Mosenthal & Kirsch, 1991). Coiro and Dobler applied the concept of self-regulated reading in the context of online reading and expanded the term to mean "the dual metacognitive processes of evaluation and regulation that occur during reading on the Internet" (2007, p. 219). With such metacognition, readers monitor their online reading processes by evaluating the relevance and accuracy of multiple online sources (Block, 1992; Coiro, 2011; Konishi, 2003; Lück, 2008; Mokhtari & Sheorey, 2002; Phakiti, 2003), and actively engage in problem solving processes such as adjusting reading rate and rereading difficult text (Anderson, 2003) as well as skimming and scanning texts (Lück, 2008). We adopted the expanded notion of self-regulation as part of our theoretical framework. Given its focus on readers' online reading metacognitive awareness, it provides an instrument to explore the nature of L2 online reading processes and how L2 readers manage their reading comprehension.

Cognitive Flexibility

Another framework that guides our study is the theory of cognitive flexibility (Spiro, 2004; Spiro, Coulson, Feltovich, & Anderson, 2004; Spiro & Jehng, 1990). In Internet reading, according to this theory, readers are expected to construct meanings from the information provided in different modalities as well as to strategically navigate through the multiple hyperlinks for reading comprehension and meaning construction. Such hypertext reading actually provides an environment in which readers are allowed to develop their cognitive strategies by trying to assemble knowledge from various sources of information (Brandl, 2002; Spiro et al., 2004). Researchers have probed the development and practice of online readers' cognitive flexibility. In Al-Seghayer's (2005) study, such cognitive strategy use was

greatly assisted when ESL learners were presented with an organizational device that provided them with an outline of the upcoming text. Ebner and Ehri (2013), who used a think-aloud protocol in their study to maintain online readers' engagement in their vocabulary learning on the Internet, found that participants' proactive and self-regulated learning reinforced cognitive flexibility when they learned word meanings from multiple online resources. Some skilled readers learn to cope with hypertext reading by experimenting with various ways of exploring online resources, while struggling or beginning learners may need teacher demonstrations of such cognitive processes (Brandl, 2002). Our study supports as well as extends the theory of cognitive flexibility by documenting online readers' emerging cognitive flexibility during information searching and reading comprehension.

Online Reading Strategies

Coiro (2003) has argued that the notion of reading comprehension ought to be broadened to include the ability to learn, comprehend, and interact with technology in a meaningful way. She suggests that three important aspects of reading (reader, text, and task) need to be expanded upon and argues that curriculum (i.e. literacy instruction, assessment, and professional development programs for teachers) should be modified to accommodate the changes brought about by the advent of hypertext. Damico and Baildon (2007), in their study of reading behaviors of ninth graders enrolled in an international school in East Asia, found that a number of factors, including purpose for reading, inquiry questions, beliefs about topics, and ability to consider multiple perspectives, together shape the ways learners interact with texts. They also confirmed that readers' purposes and their own perspectives greatly affect their Internet reading processes (Bartlett, 1932). Moreover, Leu, Zawilinski, Castek, Banerjee, Housand, and Liu (2008) explored the nature of reading processes of 53 seventh-graders with advanced online reading ability. They reported that the students go through a series of steps of inquiry using online texts: developing questions, locating information, evaluating the usefulness of information, synthesizing information, and communicating information.

Second Language Online Reading Strategies

In particular, previous research on online reading in L2 contexts has demonstrated that L2 users employ unique and strategic approaches for online reading comprehension (Akyel & Erçetin, 2009; Huang, Chern, & Lin, 2009; Konishi, 2003; Park & Kim, 2011). Konishi (2003) studied L2 readers' strategic patterns for browsing and searching information tasks and found that L2 speakers used local strategies (e.g., commenting on the meaning of words) and global strategies (e.g., using background knowledge, evaluating external sources from the Web). Moreover, L2 readers were engaged in metacognitive process such as setting goals of reading, monitoring understanding of the text, and revising their strategy use.

Akyel and Erçetin (2009) found their L2 learners used such strategies as consulting online glossaries to support L2 online reading comprehension. Also the immediate access to glossary annotations compensated for the participants' lack of prior knowledge. Huang et al. (2009) reported that L2 online readers predominantly used such support strategies as translation, dictionary consultation, and highlighting. Use of these support strategies was a strong predictor of the recall scores of all participants. Even though some of these reading strategies, such as using a dictionary, were adopted from paper-based reading (Anderson, 2003; Hsieh & Dwyer, 2009; Huang et al., 2009), the use of various types of online resources and hypermedia resources has been developed into new reading strategies for online readers (Chun & Plass, 1997; Sakar & Erçetin, 2005). More recently, Park and Kim (2011) found that L2 users employ diverse hypermedia resources (e.g., videos, pictures) and computer applications and functions (e.g., a spell checker, highlighting texts) to facilitate their online reading.

On the basis of the findings from the previous studies above, the current study extends and deepens our knowledge of how college level L2 learners of English use a wide range of online resources to support their online reading comprehension, and how they construct meaning during L2 online reading with the aid of these resources. Within these theoretical constructs, the study was guided by two main research

questions:

1. What factors inform L2 English readers' decision-making regarding reading comprehension while they read online?
2. What characterizes the process of their meaning construction using Internet resources when they read online text?

RESEARCH DESIGN

Participants

Our participants were seven graduate students from China, South Korea, and Taiwan at a US research university in the Midwest (see Table 1). Given the increasing use of information technology in these countries (Bilbao-Osorio, Dutta, & Lanvin (2013), the participants reported have spent about 30 hours in average reading online. All participants were born and educated in their respective home countries and learned English as a foreign language. Although they were second language speakers of English, as graduate students at a research university in the US, they were advanced readers of both their native languages and English. The participants' English proficiency was high, as determined by TOEFL scores (94 or over in iBT format) except for one participant who had not taken the TOEFL yet, but had a GRE verbal score of 610. Among the seven participants, three were from the school of business, two were science majors (biology and chemistry), and two were in education. Four of the participants were Korean, two Chinese, and one Taiwanese.

Table 1. Demographic Information of Participants

Name	L1	Gender	Age	Proficiency Test	Language score	Major	Years in US	L1 Internet use (hrs/wk)	L2 Internet use (hrs/wk)
Curi	Korean	M	30	PBT ¹	620	Business	1	10	15
Nara	Korean	F	27	GRE ²	610	Chemistry	1	9	1
Seo	Korean	F	33	iBT ³	98	Business	3	9	12
Cho	Korean	M	36	CBT ⁴	225	Business	2	10	4
JZ	Mandarin	M	24	iBT	102	Biology	1	21	35
QY	Mandarin	F	24	iBT	86	Health Science	2	14	21
Ping	Mandarin	M	29	iBT	94	Instructional Systems Technology	1	18	38

Curi

A Korean male student in the Master in Business Administration (MBA) program with a paper-based TOEFL score of 620, Curi had lived in the US for over a year. He spent about 25 hours a week on the Internet using Chrome as his preferred browser. Curi reported to be advanced in his computer skills and knowledge.

Nara

In the US for less than a year, Nara, was a female graduate student majoring in Chemistry. When needing online resources to assist with online reading, she preferred to use Naver, a Korean Internet portal site,

and she was very knowledgeable about what it could offer. She did not take TOEFL but her combined GRE score was 1410 (610 on the verbal section).

Seo

Seo, whose iBT score was 98, was another Korean student studying in MBA program. She had been in the US for about three years working on a MBA degree. Based on the background information survey result, she reported to spend about 21 hours a week online, including reading news articles, shopping, banking, and social networking. She reported having advanced skill in using tools for searching the Web and resources in general. In L2 reading online while surfing the Web, she used a monolingual online dictionary software (e.g., Dictionary.com) installed in her computer.

Cho

Having lived in the US for two years while getting his Masters in Business Administration, Cho reported being fairly knowledgeable about searching the Web and using Internet resources. Naver and Wikipedia were among his favorite online resources for looking up new words and detailed information about unknown terms. He scored 225 on the TOEFL CBT.

JZ

At the time of the study, JZ, a student from China, was starting his second year as a graduate student of biology in the US. He scored 102 on the TOEFL iBT test. He reported spending an average of about seven hours online reading every day, three of which were in English. According to the background information survey, he had fairly good mastery of computer skills and knowledge of website affordances, so he was able to navigate through different websites adroitly.

QY

QY was a Chinese graduate student in health science. She had been in the US for two years to seek a PhD degree. Her TOEFL iBT test score was 86 and reports reading online for about five hours per day, two of those hours in English. She preferred paper-based reading over online reading but when required to read online, she frequently used Youdao online dictionary, which is a popular online dictionary software in China.

Ping

Hailing from Taiwan, Ping was doing his Master's in Instructional Systems Technology. He scored 94 on the TOEFL iBT. At the time of his interview, he had just started his second year in the US. He spent approximately eight hours daily reading online, which included approximately two and a half hours in English. In the background information survey and interview, Ping reported being fairly tech-savvy, so he preferred to read everything online, and could navigate through various websites to collect information to support his online reading.

Instruments and Procedures

The data collection procedure for this study is outlined in [Figure 1](#) below. Details about the procedures are described in the following sections.

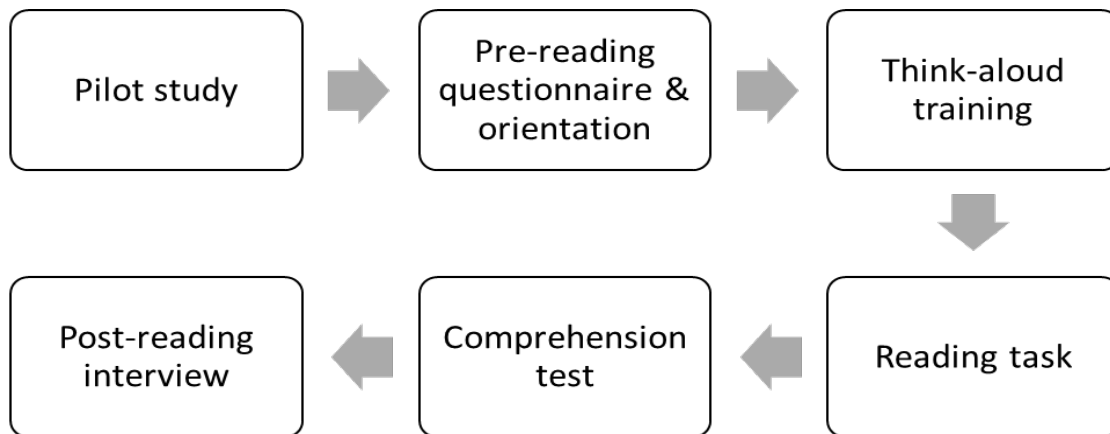


Figure 1. Data Collection Procedures

Pilot Study

The overall research design of the current study was based on Coiro and Dobler's (2007) study. Since the contexts and participants in that study were different from those in our study (L1 readers of English in elementary school), we modified data collection methods to fit our postsecondary students' intellectual and linguistic levels. For example, the participants in Coiro and Dobler's study were fifth graders, and were only allowed to use one website for answering given questions. Our participants read more complicated texts, and were not limited to the kinds of online resources they could use. Data collection methods were modified based on the information gathered from a series of pilot studies with four evaluators, who had expertise in informatics, simultaneous translation, educational technology, and second language education. They went through the modified data collection process and provided helpful comments after the process was over. None of them were among the seven participants of this study.

Before Reading

The seven participants met one of the researchers individually for the reading and think-aloud tasks. Before they read the texts, they completed a pre-study questionnaire (see [Appendix A](#)) eliciting their demographic information, TOEFL scores, and technology skills. The questionnaire was modified from the instrument used in Coiro and Dobler's (2007) study to elicit the participants' demographic information, language test scores, and the nature of their Internet use. A pre-reading interview elicited the participants' preexisting knowledge about two topics—cloud computing and global warming—on which they were about to read. They were notified that they were free to find any information from the Internet that might help them understand the online text and answer comprehension questions.

The Sound Recorder, one of Microsoft Windows' built-in programs, was used to record the entire data collection process including the interview based on the pre-study questionnaire, the pre-study interview, the think-aloud protocol, as well as the post-study in-depth interview. CamStudio software was used to simultaneously record audio and video data of the think-aloud protocol.

Think-aloud Instruction

Prior to the reading task, the participants were instructed to think-aloud. They were allowed to verbalize their metacognition in L1 (Mandarin Chinese or Korean), as they felt more comfortable using their native language. As Bowles (2010) suggested, the participants were first informed of the rationale and the purpose of this research. The researcher then provided participants with instructions for the think-aloud task by actually demonstrating it and offering them warm-up tasks to familiarize them with the verbalization process (see [Appendix B](#)).

Reading While Thinking Aloud & Reading texts

After the pre-reading questionnaire and interview, each participant read two different online texts while thinking aloud, answered 18 reading comprehension and vocabulary questions, and verbalized his/her metacognition to the researcher. The two texts read by the participants were a blog posting related to cloud computing written by an information technology expert entitled, “Telcos Could Be The Future Enterprise Software Vendor For Small Business,” and a news article on global warming from the New York Times website entitled, “Arctic Melt Unnerves the Experts” (see [Appendix C](#)). The following criteria were employed for text selection. First, the two texts should be from business and natural science fields, because the participants were graduate students from business, science, and a technical area of education. Business and education students were expected to be familiar with cloud computing, and the science students with global warming. Second, the two texts should be on topics that are growing in popularity. Lastly, the texts should contain some terminology specific to the field so that some readers would need to seek additional resources to fill the comprehension gap.

Reading Comprehension and Vocabulary Questions

Each text had nine questions that measured participants’ comprehension and understanding of key vocabulary (see [Appendix D](#)). The cloud computing blog posting consisted of one main idea question followed by eight questions that checked their vocabulary understanding. From the cloud computing text, we wanted to see how they construct meaning from a text containing several unknown words and acronyms. The global warming article contained questions that measured participants’ comprehension of main idea, inference, vocabulary, and general meaning. There were two rationales behind the question development: besides measuring our participants’ reading comprehension of the texts, we also hoped that the questions would function as catalysts for meaning construction and also as sounding boards for them to verbalize their metacognition.

There was no time limit for answering the questions. The average score for reading comprehension and vocabulary was 94.4 out of 100 ($SD=3.2$), which signaled their successful comprehension of the texts with the aid of online resources.

After reading

A post-reading interview was conducted right after each participant completed reading the texts and answering the questions in order for us to understand what we observed in the reading process. We asked clarifying questions referring to certain actions the participant took and interesting words s/he spoke while reading (see [Appendix E](#)). After initial data transcription was completed, we met each participant again to check for accuracy, as well as to seek confirmation and further illumination of the observation and interview data for each participant.

Data Analysis

Transcripts of the seven think-aloud protocols were the major source of data for analysis. For each comprehension question, a comparison was made among the seven participants as to how they went about searching for, evaluating and synthesizing information from online resources. We kept track of the websites the participants used, the reasons why they used certain resources, the sequence of using the websites, how they used them, whether they succeeded in locating information from one resource, and how they verified information through cross-references among different websites.

We then used Coiro and Dobler’s (2007, p.229) framework of readers’ online cognitive strategies as our analytical tool. Based on their study on L1 online reading, we tried to generate new themes that reflect the nature of L2 reading and add to what had already been discovered about online reading. The themes from their study are: (1) the utilization of prior knowledge sources; (2) the development of self-regulated reading strategies; and (3) the demonstration of cognitive flexibility. We identified each participant’s

information-searching strategies and categorized them into these themes. Through the rereading of the transcripts, we developed new themes to reflect the nature of our data, which was second language online reading.

FINDINGS

In this study, we explored L2 speakers' online reading with two research questions: (1) what factors inform their decision-making as they read online? and (2) what characterizes the processes of their meaning construction using Internet resources when they read online text? In the following section, we report our findings based on the two research questions.

Prior Knowledge Sources

Our second research question was about the factors that inform adult ESL readers' decision-making as they read online. Verbal and visual data suggest that our participants actively used prior knowledge during the reading process. Coiro and Dobler (2007) identified four sources of prior knowledge required for reading comprehension of young (fifth grade), skilled learners: prior knowledge of the topic, prior knowledge of printed informational text structure, prior knowledge of informational website structure, and prior knowledge of web-based search engines. Our data with advanced adult second language learners of English revealed the same categories of prior knowledge, with more complexity resulting from reading in a second language. To represent findings more accurately, we revised the four categories to: (1) prior knowledge of the topic, (2) prior knowledge of Internet services and their affordances⁵; (3) prior knowledge of informational web structures, (4) prior knowledge of printed text structures, and (5) prior knowledge of computer skills. There were two rationales for this revision. First, the participants in Coiro and Dobler's study were fifth graders whose first language was English whereas our participants were graduate students who had learned English as a second or foreign language. Second, while their study allowed the participants to use only one resource for reading comprehension, Yahoo!igans (Yahoo for young children), our participants could search openly for any online resources.

Prior Knowledge of the Topic

Knowledge about specific topics or domains (Alexander, Kulikowich, & Schulze, 1994) and vocabulary (Beck, Perfetti, & McKeown, 1982) contributes to reading comprehension and second language readers are not an exception (Park & Kim, 2011). For example, business major participants in our study had much more background knowledge about cloud computing than other majors, and some of them provided very specific answers to the vocabulary questions. They took less time to read and answer all the questions than the non-business participants did. Our data confirm Ariew and Erçetin's (2004) finding that background knowledge has a significant positive relationship with reading comprehension. However, they reported more difficulty understanding the article on global warming and took longer to finish reading and answering questions than the other majors did. This result is similar to what Carrell (1987) found in a comparison of two groups of students with Muslim and Catholic heritages. When the two groups were asked to read two texts, a Catholic-related text and a Muslim-related text, students were able to recall information better from texts they were familiar with.

The answers provided by our participants for each question differed based on their familiarity with the topic. Curi, a business administration major, said that he already knew the meaning of cash cow. Based on his pre-existing knowledge and information from the text, he provided a definition of cash cow that was specific to his field: "A business category - Traditional business items - i.e. Accounting/payroll/point of sales." Curi seemed to have had specific experiences which he activated as he answered the question about *cash cow*. Non-business participants, Nara, JZ, and Ping, who were unfamiliar with the term, chose to simply copy and paste the definition they found from the Internet as their answer. This confirms Ariew and Erçetin's (2004) finding that prior knowledge contributes more to reading comprehension than annotation use.

The results from this study indicate that knowledge learned in L1 may be of help when learners try to understand certain content written in their L2. JZ specified that he relied greatly on his L1 knowledge about cloud computing when he read the article. When he first saw the term *cloud computing* he did not exactly understand what it meant. As soon as he checked the term in Wikipedia and matched it with the Chinese term (*yun duan ke ji*), he said, “Ah *yun duan ke ji*! I know this. This is like to store things in a remote database....” He began to explain what he knew about the notion. The definitional information in Wikipedia helped him match what he already knew in his L1 with what he did not know in his L2. Once the correspondence occurred, the whole set of information and knowledge was retrieved from his L1 “database” to help him understand other related terms in the L2. Such L1-L2 term ‘matches’ happened constantly when the participants read. When Kuo read the global warming article, she checked *arctic* in an online dictionary and immediately matched the term *Arctic Melt* with the Mandarin term, *pei ji bing yuan rong hua*. When she encountered the term greenhouse gases, she could easily match it with the Mandarin *wun shi qi ti* and had no difficulty understanding the concept. Such matching does not merely signal the significance of translation; rather, it acts as a key to unlock the knowledge that is otherwise hidden behind unfamiliar terminology. Online resources help initiate L1-L2 knowledge connections given its readily accessible and up-to-date information that is often not available in off-line reading

Prior Knowledge of Different Online Resources and Their Affordances

Proficient online readers demonstrate knowledge of different online resources and what they can offer (Eagleton & Dobler, 2007). Our participants showed such knowledge in the post-reading interviews as shown in the following excerpts:

Curi:

I don't like English monolingual dictionaries because they take more time to understand the meaning of words and also sometimes I need to look up more words to understand the definition of one word. Usually I go to Naver English dictionary (<http://dic.naver.com>) for definitions in Korean. Also, when I need to understand complicated concepts for reading comprehension, I go to blogs written in Korea. For example, let's suppose I need to know how to use the differences between currency exchange rates to do some investment. There are different ways of investment. Because I do not know the concept and I do not know how to apply them in real situations.... I go to Korean Naver website. It gives me blog postings made by experts.

Nara:

I almost always use Naver. Google lists its research results based on the popularity. However, Naver provides a variety of information under different categories such as dictionary, encyclopedia, Jisikin (Q&A service), blogs, etc. I use blogs, and Jisikin.

Dictionaries usually provide decontextualized definitions whereas blogs and Jisikin [Q &A] narrate the meaning in specific contexts: they are written by people who are knowledgeable about certain topics. Ping also noted that he benefited greatly from the visual representation of abstract words or concepts. His knowledge of the affordances of the website made his reading comprehension process easier and more manageable. He also stated that “One of the good things about Google is its search engine for images. I am a heavily visual learner so it helps me a lot.”

Content and Lexical Support

One of the first decisions our online reading participants made when seeking online resources was whether they needed lexical (dictionary) or content (specialized and content specific) support. For example, when JZ encountered acronyms like *VAR* or *ISV*, he decided what the kind of support he needed

was not only lexical but also content. Therefore, he resorted to Wikipedia and Google searches to find sufficient definitional information for more thorough comprehension beyond what an online dictionary could provide.

Seo's approach to using online resources for both content and lexical support was based on her empirical knowledge of various online resources and their affordances. Seo, while responding to the question, "What does VAR mean in this blog posting?" stated:

According to the blog posting, it [VAR] seems to be a technical term, related to telecommunication area. I tend to use Naver [typing Naver address in the address bar] because Naver provides both results from Naver encyclopedia and dictionary. [Scrolling down and skimming the sub-categories and stopping at the results from Naver encyclopedia]

With her prior knowledge of different Internet resources (e.g., Naver encyclopedia and Naver dictionary), she narrowed down the results in a strategic way. When looking for definitions of target words, she used contextual cues from the online text and decided which Internet resources would help her understand the unknown target words. For example, to answer "What does VAR mean in this blog posting?" she used Naver because she needed both content and lexical knowledge of the target word. On the other hand, to answer "What does *cloud* mean in this blog posting?", she used Google and Wikipedia to search the key words *cloud computing* to get more content knowledge. She said the results from Google tended to be more diverse than those from Naver.

L1 or L2

As second language speakers of English, our participants usually began their search for online resources to assist their reading comprehension by deciding whether to seek services written in English or their first language. Ping particularly favored the Google search engine function that sorts out and presents results in Chinese. He typed in an English term and clicked on "show results in Chinese", which made it easier for him to navigate. Knowing about this Google search engine affordance helped him search for necessary information more efficiently.

Prior Knowledge of Informational Website Structures

Our participants activated their knowledge about the structures of informational websites. Their knowledge included "how to recognize and negotiate hierarchical and nonlinear hyperlinks, navigational icons, interactive multimedia, and browser toolbars" (Coiro & Dobler, 2007, p. 230). They used different web browsers and customized them for convenient browsing. Curi and Ping used the Chrome browser because they found it much faster than other browsers. Curi also liked the fact that he could customize and freely move tabs on the Chrome browser.

Such knowledge facilitated their decision-making. Curi was aware of Google's preview function and used it effectively to check if a page appeared to be useful. Nara favored Naver because it prioritizes categories based on the nature of a search word. For example, when she entered *SaaS* (Software as a service) in the search window, Naver displayed three result entries with the encyclopedia category at the top of the page. Although all three results for *SaaS* showed the same definition, each of them explained the concept as it was used in a different field. After she clicked on one with the sub-category "social science - economics - economics general," she said, "Naver is very convenient because it has sub-categories for each entry. I don't have to guess what an entry will show before I click the link. Naver categorized for me."

Familiarity with online dictionary structures was also an important aid for some participants. JZ and QY, for example, had specific reasons for favoring particular online dictionaries. JZ mostly visited Iciba because of the simple layout of its entries and its rich collection of sample sentences. QY preferred Youdao for its clear Chinese-English and English-English definitions and the provision of frequently used

collocations. She also downloaded Youdao to her handheld device particularly for its “21st Century English-Chinese Dictionary,” which gives meanings as they are used in different fields. Such background knowledge of the structures and affordances of online dictionaries helped them find ways to accommodate their various learning styles, content requirements, and other needs.

Prior Knowledge of Printed Text Structures

Readers apply substantial prior knowledge of printed text structure and features to the reading of online text. Awareness of text structure, including surface structure order and explicit linguistic and graphic cues (see Goldman & Rakestraw, 2000), contribute to reading comprehension (Carrell, 1985; 1985; Englert & Hiebert, 1984). Linguistic cues, also known as discourse markers, include connectives, rhetorical devices, function and relevance indicators, and enumeration devices. Graphic cues, which delineate the overall structure, include titles, headings, subheadings, and paragraph spacing. QY, for example, relied on her knowledge of printed text structure as she skimmed through the two online texts to grasp general ideas. She applied what she knows about the structure of an essay such as heading, lead-in and conclusion sentences to help her obtain a general idea of what the online text was about:

I think it's [reading online] just like reading something on the paper, I read headings in each paragraph before I peruse through the article. And I also read the introductory and concluding sentences in a paragraph to get a general meaning. Especially longer text like the environmental one.

Prior Knowledge of Computer Skills

Our participants employed diverse computer skills when answering the reading comprehension questions, including using the “Ctrl + F” function to locate key words in the online text, highlighting selective parts using the cursor, and copying and pasting important phrases or sentences by using the “Ctrl + C” and the “Ctrl + V” function. Moreover, they customized their online reading environment by adjusting screen or text size. For example, Seo and JZ coordinated various windows while comparing findings retrieved from different web pages. To skim through search results for information related to a target word, Seo used the “Ctrl + F” search function frequently and selectively read phrases or sentences around instances of a key word. Ping was adept at using the “Window + tab” and “Alt + tab” functions to navigate from one window to another to facilitate checking different web pages concurrently.

Self-regulated Reading Strategies

Recursive Pattern of Self-regulated Reading

According to Coiro and Dobler (2007), compared to printed texts, a more complex metacognitive process is involved when learners tackle online text in a non-linear environment. Self-regulated strategies emerge as recursive cycles of decision-making processes that include planning, predicting, monitoring and evaluating (p. 235). We based our analysis on this framework to understand how our participants demonstrated each strategy. Interestingly, we found that our data drew a more complex picture than the original analysis, due to second language reading being involved. Online references and resources in the participants' L1 come into play in the analysis of self-regulated online reading strategies.

Planning

Online readers execute planning strategies for deciding what they need to find out and where to do so among the various websites. We found that besides deciding with which website to begin, an important decision for our participants was whether to pursue lexical or content support. JZ, for instance, based this decision on his initial understanding of a term. He went straight to the dictionary when the word he encountered was new, and he visited Wikipedia and Google when a term was not entirely new, but might have further meanings he was unaware of (e.g., VAR, SaaS).

Another factor that influenced our participants' planning was the language of the websites. Curi preferred Korean language websites for lexical support. He said he could understand a definition more clearly and quickly when he used an English-Korean dictionary and resorted to an English dictionary only when a Korean definition was not sufficient. However, for English acronyms, he chose to go to Wikipedia or Google because he believed that the acronyms, specific to English, would be better explained on English language websites.

Predicting

At this stage, readers make predictions as to where a certain decision (e.g., a hyperlink) will lead them and what information they can obtain from a certain website. A major concern of our participants was whether a website could help them understand unfamiliar words and concepts. Prediction was closely related to participants' prior knowledge of website structure discussed above. The more familiar they were with the website structure, the more precisely they were able to predict if they could obtain what they needed from it. Following are some excerpts that illustrate their predicting strategies:

"Often times I use Youdao dictionary. I think Youdao dictionary is sufficient enough for me to get the meaning of the word... [typed *Telcos* in Youdao]." (QY)

"From the dictionary I know what 'leverage' means.... But I cannot fit the meaning into this passage....Let me check Google Image—maybe it can give me some other answers...." (Ping)

"I am going to use Naver's general search and see if Naver encyclopedia can provide information that I need to answer the question. [typed 'ISV' in Naver]." (Nara)

Monitoring

Readers need to constantly monitor their comprehension and the relevance of the resources they find. Our participants appeared to go through two stages of monitoring. The first stage was monitoring a list of links provided by search engines and clicking on a link that looked right (Park & Kim, 2011). The second stage was monitoring whether the website contained information that the participant needed for better reading comprehension. For example, participants had to skim through eight Wikipedia results for the acronym *ISV*. JZ, who constantly applied this strategy when he visited Wikipedia and Google, indicated that he did so in order to monitor the relevance of a hyperlink. Seo used two different websites (Naver and Google) simultaneously in order to evaluate the relevance of information through triangulation. Finally, she came back to the target text to confirm the contextual meaning of a target word. Our findings thus illustrate that skilled readers are actively involved in sequential process of monitoring comprehension through finding relevant information from online resources.

Evaluating

Critically evaluating information is an important aspect of online reading (Leu, et al, 2011) that involves the ability to determine the accuracy and reliability of information and to recognize biased information. Our participants consulted multiple resources to verify the information they found. When QY searched for *Telcos* in the Youdao dictionary, she found that it gave her "a very weird definition in Chinese. I am sure this is not what I want...So I need to look it up somewhere else..." Realizing immediately that the dictionary was not an appropriate tool in this case, she went to Wikipedia.

Such verification of information was critical for obtaining accurate and complete information. QY knew that she needed other resources to complement her understanding of *leverage* when she found the literal Chinese definition in the Youdao dictionary. She then went to Wikipedia and found a finance-related definition that she was able to link to the text. After she had evaluated and synthesized the information, she was able to conceptualize *leverage* in context. Within this stage we found a cycle of evaluating and verifying recurring until a participant had satisfactorily grasped the meaning of a term.

All four stages appeared to be involved in recursive cycles of decision-making processes (Figure 2) as participants tried to understand the vocabulary in the readings. If they found the information incomplete, inappropriate, or dissatisfying, they went back to previous stages to recommence the search in a different search engine, or clicked on a link that took them to a new website (in either the L1 or the L2). The arrows in Figure 2 represent the recursive nature of the decision-making process. The trial was sometimes repeated several times until participants felt they had obtained accurate and useful information.

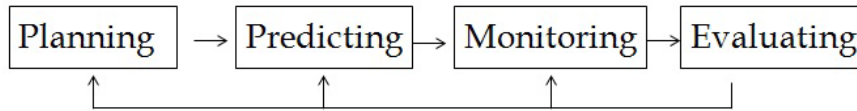


Figure 2. Recursive pattern of self-regulated reading (Based on Coiro & Dobler, 2007, p. 235)

DISCUSSION

L2 Online Readers' Knowledge Construction

Based on our participants' online reading behaviors that demonstrated their self-regulated reading strategies, we have conceptualized how L2 online readers construct knowledge in the online environment as follows. During the reading process, they were creating a "web of knowledge" from various sources as illustrated in Figure 3. They navigated between dictionaries (L1-English and English-English), Wikipedia, search engines, various website resources, and other language-specific websites to accumulate and verify information. The arrows are bi-directional, which shows that the knowledge construction process is not a one-way process. They recursively went back and forth among various online resources and affordances to construct knowledge of a term or a concept.

It has been found that an important feature that characterizes second language learners' online reading comprehension is how they resort to their first language in the process of creating the web of knowledge (Chun, 2011; Grabe, 2009). From the very beginning (planning), over half started by determining whether they needed lexical support or content support, which is a striking difference from L1 online reading comprehension processes as reported by Coiro and Dobler (2007). For lexical support, five out of seven went to online dictionaries in their L1 and some even visited more than one dictionary site to verify word meanings. For content support, they used sites that gave definitional information both in their L1 and in English, constantly switching back and forth between their L1 sites and English sites for triangulation.

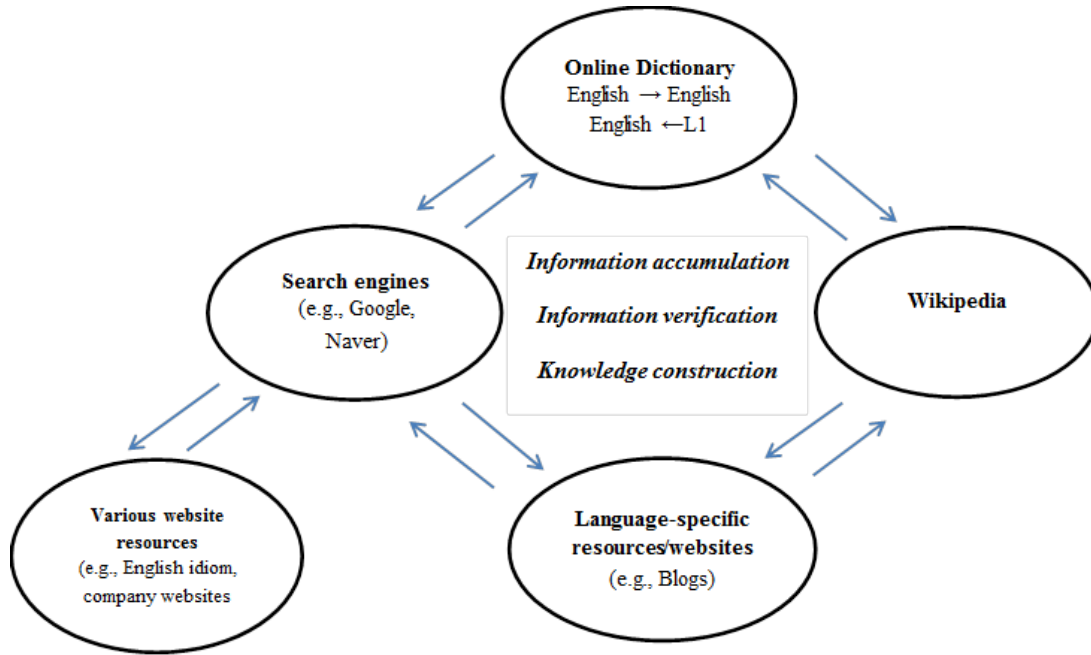


Figure 3. Construction of the web of knowledge

Demonstration of Cognitive Flexibility

As skilled readers rely on a flexible use of reading strategies (Spiro, 2004), our study attempted to extend the theory of cognitive flexibility (Spiro et al., 2004; Spiro & Jehng, 1990) and also to support Coiro and Dobler's (2007) findings. The online reading environment in particular allows readers to develop cognitive flexibility with the immense resources available in that medium (Coiro & Dobler, 2007). The findings from this study allow us to observe the way the participants explored the knowledge online, which is represented and demonstrated from multiple perspectives. Such non-linear yet resource-abundant online environment enables learners to develop cognitive flexibility (Brandl, 2002), ultimately leading to the restructure of their knowledge (Spiro & Jehng, 1990; Spiro et al., 2004). We found that they (1) assembled relevant information by fully harnessing advanced computer and search skills, and (2) integrated and evaluated the information retrieved from various resources, to achieve the construction of knowledge. We extended the theory by explicating that, such flexibility was manifested in the following domains according to our observation: diverse knowledge gains, broadened scope of information searching, and personal applications of online resources.

Diverse Knowledge Gains

The non-linear online reading environment, which poses a challenge for readers to locate and critically evaluate information, necessitates their learning to be more flexible and open to all possible ways of locating necessary information, which creates opportunities for them to gain diverse knowledge (Coiro, 2003). For instance, it was not easy for these participants to determine the meaning of *telcos*. Although it could mean telephone companies, our participants had difficulty deciding that this was the meaning the author intended and used several different resources to verify it. Curi used a European telecommunication company's website, Google, and Wikipedia, which gave him information from different perspectives. Ping referred to both texts and images to help him understand the concept. In such ways, participants exercised the cognitive flexibility to gather and synthesize knowledge from a range of resources to reach adequate understanding of a phrase or a concept. This supports Ebner and Ehri's (2013) study, which indicates that vocabulary learners' cognitive flexibility and learning are facilitated when

they effectively construct meanings from multiple online resources.

Broadened Scope of Information Searching

We found that during the process of constructing meanings and restructuring knowledge from multiple resources, the participants learned to broaden the scope of information searching. JZ researched the term *Telcos* with an online dictionary in the beginning and then went to Wikipedia, but the search was not successful. He then went to Google and found that one of the search result entries was about a company called *Telcos Systems*. Having predicted that he might find something useful, he clicked on the link and found a definition he considered authentic. He said, “This is very neat. Isn’t the company’s definition of the word the best one? That’s what they do, so we definitely can find the most precise definition from them...” In the interview, he indicated that he learned there are multiple ways to search for something online. People need not be confined to the information in Wikipedia or dictionaries; rather, they should explore other resources for verification of the information. This strategy made JZ’s searches more productive. Such display of cognitive flexibility parallels Brandl’s (2002) study that online readers learn to cope with online texts by experimenting with various ways of exploring online resources.

Personal Applications

Because the online environment involves greater complexity and demands greater cognitive capability, readers devised their own personal applications (Coiro, 2003) of search engines, such as strategic approaches to narrowing down possible results. For instance, while pursuing the meaning of *cloud*, Cho first used Google and Wikipedia. When he realized that using the broad key word *cloud* would retrieve too many irrelevant results, he used *cloud computing* instead. JZ, too, typed in *VAR agreement* and *ISV acquisition* rather than merely the acronyms *VAR* and *ISV* in Wikipedia, to obtain more precise information. He said, “I found that when you type in a complete phrase instead of word, you get more precise meaning.”

JZ developed another personal appropriation of search engine application. When he searched Google for *leverage the cloud*, he used different word orders (*leverage cloud*, *cloud leverage*, *leverage the cloud*, and *the cloud leverage*) in Google and retrieved different search results. By doing this, he was able to examine a wide variety of options for verification and finally found a satisfying answer.

The two strategies, using computer search skills and integrating information, were demonstrated throughout the tasks as a manifestation of cognitive flexibility. The first strategy aligns with the findings in Lück’s (2008) study that indicated that skimming and scanning, which require learners’ computer search skills, are essential in L2 online reading. This observation also supports Al-Seghayer’s (2005) study that well-structured hypertext appears more conducive to learners’ knowledge construction, due to the fact that some participants obtained better understanding when they visited better-structured websites like Wikipedia.

New Literacy Skills Required in Online Reading Environments

With the perspective of new literacy which is essential, even required, for readers who have to tackle different problems and difficulties emerging from the online reading environment (Castek, Coiro, Hartman, Henry, Leu, & Zawilinski, 2007; Coiro, 2003; Coiro & Dobler, 2007), we attempted to highlight the ESL online readers’ use of new literacy skills involved in problem-solving processes with informational online text in which limitless resources and information are presented in a non-linear manner. As findings from our participants indicated, text reading strategies were not sufficient to support learners’ achievement of successful online reading comprehension; they thus needed to develop new literacy skills demanded by the nature of the online reading environment.

These new literacy skills were associated with the following five domains: (1) identifying problems and questions, (2) locating information from multiple online resources, (3) critically evaluating information

online, (4) synthesizing information online, and (5) communicating and exchanging information online. These strategies parallel those found among L1 readers of English (Coiro, Knobel, Lankshear, & Leu, 2008; Leu, Kinzer, Coiro, & Cammack, 2004; Mokhtari et al., 2008) though the strategies of the international graduate students appeared to be more complex, multiple, and extended than were those reported by L1 studies. Though some of these strategies are clearly related to second language users (e.g. consulting resources in L1), it is unclear to what extent other more elaborate strategies may be attributed to differences in age rather than in language background. Our data allow us to concentrate on three domains of new literacy skills: (1) locating information, (2) critically evaluating information, and (3) skillfully synthesizing information.

Locating Information

Online readers need to know where and how to locate useful or critical information. This may include knowing how to use search engines and interpret the results, which websites to visit, and how to navigate through embedded hyperlinks and multiple modalities of information representation like texts, graphics or video clips. These skills help learners to effectively find resources to support their online reading comprehension. We observed our participants developing such skills when they went through the planning and predicting stages.

Evaluating and Synthesizing Information

In cyberspace, where everyone can publish his or her own opinions and interpretations, it is particularly essential for readers to be able to evaluate the authenticity of Internet information and critically distinguish between biased and unbiased sources (Leu et al., 2004) and knowing how to verify information from various resources emerges as a key skill for assessing authenticity. After this evaluation, the next phase was to use the information to solve problems by synthesizing information from multiple online resources.

When our participants proceeded to the monitoring and evaluating stages, we observed such new literacy skills emerge as they tried to put pieces of information into a big picture. For some participants (JZ and QY), this set of skills developed during several unsuccessful trials of locating accurate information. JZ specifically reported what he learned from the information searching experiences in the interview.

IMPLICATIONS

While we have gained a wealth of insights in this study, we suggest that it is only the beginning of needed research on self-regulated online reading strategies of L2 speakers. The current study examined online reading of only particular Asian students, and there exists the need for extension of this research to other groups who may bring different educational experiences and backgrounds to the online reading process. Future studies could replicate our design with larger groups of similar participants or investigate a wider range of readers, including K-12 students, professional and non-professional adults, as well as all levels of post-secondary education. We also suggest that researchers particularly investigate online strategies of less proficient second language learners, which could help teachers understand how to aid those who are left behind in terms of online reading ability. In addition, we also suggest longitudinal studies in order for researchers to discover more emergent literacy practices that might not be found in short-term studies.

Until now, few studies have investigated language learners' use of online resources to activate background knowledge during their L2 reading (Chun, 2011). In this study, we identified five different kinds of prior knowledge being activated during their L2 online reading: prior knowledge of the topic, Internet services and their affordances, informational web structures, printed text structures, and computer skills. L2 reading education can benefit from this new knowledge gained in our study. Since successful readers demonstrate higher levels of metacognitive knowledge (Paris, Lipson, & Wixson, 1983), L2 reading instruction should enable students to engage in metacognitive awareness and monitoring during

their reading, and we hope that what we have reported in this paper will benefit L2 online reading educators.

APPENDIX A. Pre-Study Questionnaire

1. Name
 2. What is your home country?
 3. What is your major?
 4. What is your gender?
 - Female
 - Male
 5. What is your degree program?
 - Undergraduate
 - Graduate
 - IEP
 6. What is your English test score? (e.g. TOEFL, IELTS, TOEIC, etc.)
 7. How many years have you stayed in the US?
 8. How many hours in a week do you use the Internet?
 9. What kind of tasks do you do online? (Please, check all that applied)
 - Reading newspaper
 - Reading magazines
 - Reading documents
 - Shopping
 - Hotel/travel reservation
 - Social networking (e.g. Facebook, Myspace, etc.)
 - Running Personal website/Blog
 - Banking
 - Photo sharing (e.g. Flickr, Picasa, Photobucket, etc.)
 - Listening to music (Pandora, Live365, Jango, etc.)
 - Movie/TV (Rotten Tomatoes, Netflix, etc.)
 - Game
-

APPENDIX B. Think-aloud protocol instructions

1. Reason for thinking aloud

In this research we investigate how English as second language readers comprehend online texts and how they are using online resources to aid their understanding. Therefore, we are interested in what you think when you complete the two online reading tasks. During the task, you will be given two different online texts written in English: one is a blog posting about cloud-computing in business, and the other is a news article about global warming in natural
-

science.

2. Think-aloud instruction

As you go through reading two online texts, you are asked to think-aloud. What we mean by “think-aloud” is that we want you to say out loud whatever you are thinking in your mind while you read. The “think-aloud” is more like saying to yourself while reading, so you don’t necessarily have to explain your thoughts.

3. Think-aloud demonstration and Warm-up practice

The researcher gives you a brief demonstration of think-aloud in reading. After the demonstration, you are asked to do a short warm-up practice of think-aloud. If you have any questions, please feel free to ask.

APPENDIX C. Screenshots of Online Reading Texts



CLOUD COMPUTING
Technology. Strategy. Innovation. Design

Tuesday, September 21, 2010

Telcos Could Be The Future Enterprise Software Vendors For Small Businesses

Having worked on enterprise software product and go-to-market strategy for SMB (small and medium businesses), I can tell you that these are the most difficult customers to reach to, especially the S in SMB. It's an asymmetric non-homogeneous market for which the cost of sales could go out of control if you don't leverage the right channels. The competitive landscape varies from region to region and industry to industry. In many cases instead of competing against a company you would be competing against a human being with paper-based processes.

Tomorrow I am speaking at the [Razorsight](#) annual conference on the topic of cloud computing. I am excited to meet their customers, the telcos. While I prepare for my keynote, I can't stop thinking about the challenges that the telcos face and the opportunities that they are not pursuing. My keynote presentation is about how telcos can leverage the cloud, but this blog post is about how telcos can become successful enterprise software vendors and market their solutions to small businesses.

There are very few things that are common across small businesses. They own a landline (at least for now) and they have Internet access, in many cases from the same vendor. I believe that the landlines will be more and more difficult to sell to these customers, but losing a channel – a relationship – would be even worse. If leveraged well, these relationships could be worth a lot more compared to the landline business as it stands today. Just think about it. Selling to small businesses is all about leveraging existing relationships with them. This channel is priceless.

What will it take for the telcos to market products to small businesses?

ISV acquisitions or VAR agreements: If telcos are bundling software, on-premise or SaaS, the telcos, as organizations, don't necessarily have the skills or resources to


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ARTS
STYLE
TRAVEL
JOB 8
REAL ESTATE
AUTO 8

ENVIRONMENT
SPACE & COSMOS

Arctic Melt Unnerves the Experts




Andy Armstrong/National Oceanic and Atmospheric Administration

Refresh A photograph taken in August from an icebreaker research cruise in the Arctic Ocean, about 600 miles north of the Alaska coastline.

By ANDREW C. REVKIN
Published: October 2, 2007

The Arctic ice cap shrank so much this summer that waves briefly lapped along two long-imagined Arctic shipping routes, the Northwest Passage over Canada and the Northern Sea Route over Russia.

Multimedia



Interactive Graphic

Over all, the floating ice dwindled to an extent unparalleled in a century or more, by several estimates.

Now the six-month dark season has returned to the North Pole. In the deepening chill, new ice is already spreading over vast stretches of the Arctic Ocean. Astonished by the summer's changes, scientists are studying the forces that

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5. Op-Ed Contributor: Doctors Have Feelings, Too
6. Beers of The Times: Ale to Usher in Baseball Season
7. Well: The Chocolate Diet?
8. Knowing Cost, the Customer Sets the Price
9. Obama vs. Boehner: Who Killed the Debt Deal?
10. The Stone: Fugitive Slave Mentality

[Go to Complete List >](#)

APPENDIX D. Reading Comprehension Questions: Cloud Computing & Arctic Melt Unnerves the Experts

Cloud Computing

1. What is this blog posting about?
2. What does *telcos* mean in this blog posting?
3. What does *leverage* mean in this blog posting?
4. What does *ISV* mean in this blog posting?
5. What does *VAR* mean in this blog posting?

-
6. What does *SaaS* mean in this blog posting?
 7. What does *cash cow* mean in this blog posting?
 8. What does *cloud* mean in this blog posting?
 9. What does *leap frog* mean in this blog posting?
-

Arctic Melt Unnerves the Experts

1. What is this news article mainly about?
 2. What instrument or tools did Son Nghiem use in his research?
 3. According to the reading, what seems to be related to the global warming?
 4. According to the reading, which countries seem to pay attention to the issue of global warming?
 5. According to the reading, why is the ice retreat likely to be bigger next summer?
 6. What does Arctic Oscillation mean?
 7. Why did many Arctic researchers warn that it was still far too soon to start sending container ships over to the Arctic region?
 8. Name three of the Arctic experts mentioned in the article.
 9. In the last paragraph, what does *ace up her sleeve* mean?
-

APPENDIX E. Post-Reading Interview Questions

1. How was today's reading? Article 1, Article 2?
2. Why do you use _____ (website or an online tool)?
3. What other strategies do you usually use when you read online texts?
4. Why was it easy, or difficult?
5. Who do you think are good online readers?
6. Do you think reading online helps L2 readers? Why?
7. Is online reading different from traditional reading? To what extent?
8. Can you share anything today's activity made you think?

(The researchers may add some more questions that they think are necessary. But the total interview time will not be over thirty minutes.)

NOTES

1. PBT: The TOEFL® paper-based Test, scored on a scale of 310 to 677 points. Retrieved from <http://www.ets.org/toefl/pbt/scores/understand/>.
2. GRE: The GRE® General Test, scored on a scale of 200 to 800 points. This was discontinued and replaced by the GRE Revised General Test in August 2011. Retrieved from https://www.ets.org/gre/revised_general/scores/.
3. iBT: The TOEFL® Internet-based Test, scored on a scale of 0 to 120 points. Retrieved from <http://www.ets.org/toefl/ibt/scores/understand/>.
4. CBT: The TOEFL® computer-based Test, scored on a scale of 0 to 300 points. This was discontinued and replaced by iBT in September 2006. Retrieved from <http://www.ets.org/toefl>.

5. Affordance is defined as the quality of an environment, which allows an individual to perform an act. In this study, this term is used to indicate what online resources can offer for readers to perform efficient online reading.

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