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STUDENTS WITH LEARNING DISABILITIES AND THE WORLD WIDE WEB: TEACHING INFORMATION PROBLEM SOLVING TO IMPROVE EXPOSITORY REPORT WRITING

By

Svjetlana Curcic

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ABSTRACT

STUDENTS WITH LEARNING DISABILITIES AND THE WORLD WIDE WEB: TEACHING INFORMATION PROBLEM SOLVING TO IMPROVE EXPOSITORY REPORT WRITING

By

Svjetlana Curcic

This study examined the effectiveness of instruction in learning with the Word Wide Web (the Web) in which 20 seventh and eighth grade students with a learning disability in reading (LD) were taught information problem solving skills. An experimental pretest-posttest repeated measure design was used to investigate the effects of intervention in which the treatment group was instructed in the Big6 Skills model to information problem solving. Both groups used an Essay map as a visual organizer.

Both groups significantly improved in the quality of writing and navigation. The results show that the treatment group significantly outperformed the control group on the measure of text length. The treatment group posttest scores showed a significant improvement in writing organization. Correlational analyses showed no significant differences between the control and treatment group in prior knowledge, motivation, or gender.

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CHAPTER 1

INTRODUCTION

Background

Learning with the World Wide Web (the Web) on the Internet has been integrated into most states' educational standards and schools (Swanson, 2006). The National Center for Education Statistics (NCES) reports that in 2005 nearly 100% of schools had access to the Internet as opposed to 35% in 1994 (Wells & Lewis, 2006). The recognition of the widespread use of the Internet, which begins in early childhood, prompted NCES to include in their reports children as young as three years of age (DeBell, 2005). About two-thirds of children in nursery schools (67%) and 80% of kindergartners used computers in 2003, and about one quarter (23%) of children in nursery schools and about one-third (32%) of kindergarteners used the Internet. DeBell and Chapman (2006) report that, overall, most K-12 students use computers and the majority use the Internet: 91% (53 million) of children age three through grade 12 use computers, and about 59% (35 million) of them use the Internet.

Students' computer and Internet use are of interest for several reasons. DeBell and Chapman (2006) and Wagner and Kozma (2003) report that the use of computers and the Internet is interdependent with literacy and associated with improvements in education, labor market prospects, and everyday lives. The Partnership for 21st Century Skills (2006) also states that information literacy and technology skills are considered to be very important, in addition to basic knowledge and skills such as reading, writing, and mathematics, for those entering the workforce. In 2003, 84% of adults with a bachelor's degree were Internet users, as opposed to 47% of those with a high school diploma, or

20% of those without a high school diploma (DeBell & Chapman, 2006). The recognition of the importance of information literacy prompted policymakers to propose changes in Part D Sec. 271. Title II of No Child Left Behind through passing the Achievement Through Technology and Innovation (ATTAIN) Act. One of the stated purposes of the ATTAIN Act is to ensure that every student has access to individualized, rigorous, and relevant learning through technology which is going to be measured at least once by the eighth grade (Washington D. C., 110th Congress Session, 2007). The International ICT Literacy Panel (2002) defines information-communication-technological (ICT) literacy as "using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society" (p. 10).

According to the U. S. Department of Commerce, the majority of students use the World Wide Web for school assignments: 13.5% of children 3 to 5 years of age, 46% of children 6 to 9 years of age, 84% of 10- to 14-year-olds and 91% of 15- to 17-year-olds, work on Web-related school assignments (Day, Janus, & Davis, 2005). A number of studies report on students' interaction with the Web in classrooms. For example, students are involved in Web-related science inquiry projects (e.g., Hoffman & Krajcik, 1999; Jones, 2002; Lyons, Hoffman, Krajcik, & Soloway, 1997; McCrory Wallace, Kupperman, Krajcik, & Soloway, 2000) and social studies projects (Jackson, 1996; Wolf, Brush, & Saye, 2003). Students also search the Web for historical information (e.g., Pritchard & Cartwright, 2004) and literacy projects (e.g., Eagleton, Guinee, & Langlais, 2003; Parks, Huot, Hamers, & Lemonnier, 2005).

In addition, students use the Web outside of school. A study by the Kaiser Family Foundation (2005), based on a nationally representative survey of over 2, 000 young people (grades 3 through 12), reports that the amount of time spent on visiting various Web sites and playing games has increased significantly from 1999 to 2004. Within that period, the time that 8- to 18-year-olds spent visiting Web sites has doubled from 7 to 14 minutes per day, and the time playing computer games has increased from 12 to 19 minutes per day. New daily activities that barely existed in 1999, such as instant messaging (17 minutes) and using some form of computer graphics (e.g., PowerPoint, photo editing, design), contributed to a significant increase in overall daily computer time of young people from 27 minutes in 1999 to 62 minutes in 2004.

A report by the Pew Internet and American Life Project reveals that teenagers use the Web to forge new and old relationships with friends and to manage (e.g., www.myspace.com) their online identities (Lenhart & Madden, 2007). Various identities and social worlds also are constructed through Web sites that serve as outlets for young people (e.g., zines) to express their values and beliefs (e.g., Guzzetti & Gamboa, 2004; Knobel & Lankshear, 2002). Burnett and Wilkinson (2005) report that elementary students' searches on the Web include exploring information for personal interests, games, popular culture, and online shopping, in addition to school projects. Similarly, in Curcic's (2005) study, elementary students engaged in auction trading (independently, using neopoints, a currency earned at www.neopets.com "shops and auctions" page), chatting with friends and family, and searching for specific information of interest (e.g., a specific car type, MP3 player, etc.)

In spite of students' engagement in such diverse school-related and out-of-school practices, the literature review by Kuiper, Volman, and Terwel (2005) suggests that students involved in learning with the Web need training and support in search skills and management of information. Kuiper and colleagues also report that there is an insufficient knowledge base about the Web and students with disabilities. The present study aims to contribute to the understandings of learning in electronic environments such as the Web, as well as to practical discussions on how to support such learning. The focus is on seventh and eighth grade students with a learning disability (LD) in reading, who may have difficulties making sense of text and hypertext.

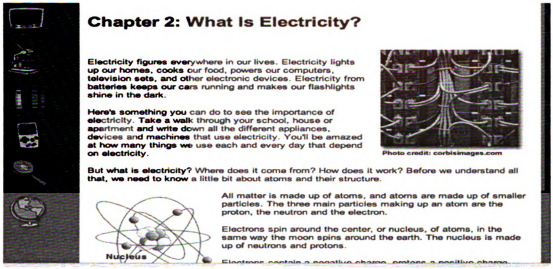
The U.S. Department of Education (2002) defines a specific learning disability (LD) as a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations. The estimates of the number of students with reading difficulties among students with LD are as high as 80% to 90% (Gersten, Fuchs, Williams, & Baker, 2001; Vaughn, Bos, & Schumm, 2007). While there is very little empirical research on struggling readers' interaction with the Web, some researchers suggest that these students' difficulties with traditional print will carryover to electronic texts (e.g., Coiro, 2005; Leu, 2000). This suggestion seems plausible for several reasons. First, learning with the Web is not unlike learning with traditional texts (e.g., Coiro & Dobler, 2007; Duke, Schmar-Dobler, & Zhang, 2006). Reading is still one of the prerequisites for learning in both of these contexts and reading remains a challenge for students who may experience phonological, orthographic, and text comprehension difficulties.

Second, some studies reveal that students transfer their comprehension strategies from traditional texts to the Web. For example, Schmar-Dobler (2003) documented how fifth graders activated their prior knowledge, monitored and repaired comprehension, determined important ideas, and asked questions while reading on the Web. These are reading strategies also identified as those used by accomplished and expert readers (e.g., Duke & Pearson, 2002; Pressley & Afflerbach, 1995). At the same time, students with LD and poor readers are sometimes described as being deficient in applying strategies while reading (Flavell, 1970; Englert & Thomas, 1987; Gaultney, 1998; Winograd, 1984). So, they are likely to have few effective strategies to deploy during Web-based reading.

Third, Web reading involves decision-making that pertains not only to texts but also to the selection of links and icons within texts (e.g., Coiro, 2003; Bolter, 1998). Hypertext, as a source of information on Web pages, involves texts and ideas that are "interlinked to one another in multiple ways" (Burbules & Callister, 2000, p. 43). The structural format of the Web, with icons and hyperlinks, adds skills to be mastered such as navigational skills (e.g., Wenger & Payne, 1996). With no fixed text structure on the Web, the search for information appears to be more demanding than information search within traditional texts (e.g., Kozma, 1991). For example, on the Web page related to the topic "What is Electricity?" (http://www.energyquest.ca.gov/story/chapter02.html), there are icons next to the text representing a computer, microscope, shelved books, hand-held device, magnifying glass, and globe. Pointing to these icons reveals links and what they stand for: a computer stands for and is a link to "Energy story", the microscope links to "Science projects", books on the shelf links to "Library", the hand-held device links to

"Games", the magnifying glass links to "Search for EQ", and the globe links to "Links". Figure 1 shows the screenshot of this Web page (links are accessed by pointing at one of the icons on the left).

Figure 1. Screenshot with text and icons.



Source: Copyright © 2006, California Energy Commission.

In interacting with the Web, students may (a) read/view/search for information; (b) make decisions about which pathways to follow; (c) judge usefulness of pathways; (d) evaluate which information is relevant for the task at hand; and (e) use strategies to extract and preserve information deemed relevant.

This study aims to examine how we can support the interaction of students with reading difficulties with the electronic environment of the Web as they engage in the processes mentioned above. The specific focus in the present study is on the task of text search on Web pages relevant to seventh and eighth grade topics selected from science and social studies curricula. Guthrie and Mosenthal (1987) note that text search, or locating information in text, is prevalent in both school and work contexts.

Dreher and Guthrie (1990) suggest that a text search involves finding information related to a specific goal. On the other hand, the goal of reading information for the purposes of text recall involves remembering contents of a text, a goal usually associated with traditional reading comprehension (e.g., Guthrie & Mosenthal, 1987; Mikulecky, 1982). Although Guthrie and Mosenthal (1987) advocate conceptual distinction between these two goals of reading (for information search and for information recall), the two goals in practice often overlap. For example, to evaluate the importance of information for a task at hand, we read information in context, and therefore summarizing (parts of) texts may be involved in both tasks.

Because students seem to be involved with the Web outside school, they are likely to develop some knowledge about hypertext features such as links and icons, or more broadly, some of the "grammar of visual design" (Kress & van Leeuwen, 2006) without explicit instruction. However, as the literature review in the next chapter reveals, students could benefit from instruction in the processes related to the search for information. These findings should not come as a surprise given the fact that students often show difficulties with "reading-to-locate information tasks" in traditional textbooks as well (Dreher, 1995, p. 1).

The ability to identify important elements in a text may be linked to readers' strategies (e.g., Englert & Thomas, 1987; Winograd, 1984), grade/age level and expertise in reading (e.g., Brown & Day, 1983; Englert & Hiebert, 1984), prior knowledge (e.g., McNamara, Floyd, Best, & Louwerse, 2004; Symons & Pressley, 1993), and motivational variables (e.g., Reynolds & Symons, 2001; Wigfield & Guthrie, 1997). Expository texts may be particularly challenging for elementary students with a learning

disability in reading (LD), who are, along with other students, more often exposed to narrative texts in the early grades (Duke, 2000). Research also shows (e.g., Englert & Thomas, 1987; Winograd, 1984; Williams, 2003) that students with LD in reading are less active in using metacognitive skills and strategies while reading and tend to import more irrelevant information into their summarization of texts.

On a positive note, studies with K-12 students and their search for information show that students, including poor readers, benefit from instruction in search strategies with traditional texts (e.g., Dreher, 1995; Dreher, Davis, Waynant, & Clewell, 1997; Dreher & Sammons, 1994; Symons, MacLatchy-Gaudet, Stone, & Reynolds, 2001). In addition, a number of interventions have been designed to promote students' development of self-regulation, metacognition, and strategic approaches to reading (e.g., Denton, Vaughn, & Fletcher, 2003; Englert & Mariage, 1991; Gersten, Fuchs, William, & Baker, 2001; Meltzer, Katzir, Miller, Reddy, & Roditi, 2004; Paris & Oka, 1989; Pressley, Johnson, Symons, McGoldrick, & Kurita, 1989; Williams, Hall, Lauer, Stafford, DeSisto, & deCani, 2005). However, interventions focused on strategies that address information literacy needs of students within electronic environments are scarce.

To address informational needs of students, Eisenberg and Berkowitz (1987) developed a Big6 Skills curriculum focused on six steps in an information problem-solving process: (1) Task definition; (2) Information seeking strategies; (3) Location and access; (4) Use of information; (5) Synthesis; and (6) Evaluation (for more information, visit: http://www.big6.com). Although this curriculum has not been developed primarily for students with disabilities and their interaction with the Web, it has been reported that this model is frequently used in the U.S. for information problem solving tasks (e.g.,

Kuiper et al., 2005; Carey, 2003). The purpose of this study is to examine whether the Big6 Skills may serve as a tool to simplify text search and support students with and without LD in the process of information location and management. A number of reports (e.g., Jansen & Culpepper 1996; Spitzer, 2000; Wolf, Brush, & Saye, 2003) advocate the use of the Big6 Skills approach in K-12 education. However, empirical studies with the focus on the Big6 in K-12 setting are limited.

Wolf, Brush, and Saye (2003) conducted a study with 18 eighth grade students and concluded that the Big6 Skills "may act as a metacognitive scaffold that supports students while they become more adept at monitoring their own thought processes during the problem solving" (p.18). Written artifacts, journals, and exit interviews revealed that students indeed developed metacognitive skills while implementing the Big6 Skills. As Wolf and colleagues (2003) suggest, it would not be surprising to find that students benefit from strategy instruction. The present study aims to determine whether instruction in the Big6 Skills benefits students with LD in reading in their information problem solving and their text search on the Web.

Windschitl (1998) notes that educators have developed many classroom activities and projects based on the use of the Web, but that the literature does not address critical questions such as "Are these practices helping students, and, if so, how?" (p. 28). These two questions—if and how—are central to the present study. As research is scarce about the informational processing skills of students with LD, an investigation into the role of the Big6 Skills in learning with the Web, focused on information location and management, could provide a valuable knowledge base.

Statement of the Problem

As participation in literacy practices is increasingly mediated by technology, some authors note that the term literacies, rather than literacy, better captures the increasing multiplicity of literacy practices (Coiro, Knobel, Lankashear, & Leu, 2008; Leu, 2002; The New London Group, 1996). Educational tasks assume new complexities within electronic environments and some authors draw attention to both current definitions of literacy and literacy instruction as inadequate (Leu, et al., 2004). Leu and colleagues view new information-communication technologies, particularly the Internet, as essential in preparing students for new literacies because new technologies are seen as central to the acquisition of knowledge.

The International ICT Panel (2002) proposed five critical components of ICT literacy, "a set of skills and knowledge presented in a sequence that suggests increasing cognitive complexity." (p. 11). They defined these components as:

Access: knowing about and how to retrieve information.

Manage: applying an existing organizational scheme.

Integrate: interpreting and representing information, summarizing, comparing and contrasting information.

Evaluate: judging the quality, relevance, usefulness, or efficiency of information.

Create: adapting, applying, designing, inventing, or authoring information (p. 11).

While literacy skills that include not only access to information but also its management and use are considered critical for success in education and life (e.g., ICT Panel, 2002; DeBell & Chapman, 2006), we know little about students with LD and their performances on such tasks. Research about students' Web searches on the Internet

shows that most students could use instruction and support in their information problem solving. Although reading and writing are still viewed as central to new literacies (e.g., Leu et al., 2004), Leu (2002) suggests that new strategies for the location, evaluation, and use of information are required. The New London Group (1996) iterates that literacy practices cannot be simply reinvented by students but need to be learned. Therefore, one of the implications of integrating the Web into classrooms is a need to understand how learning in electronic environments may be facilitated.

Research shows that strategic readers in electronic environments engage in online reading employ strategies used by competent readers with traditional texts (offline reading) (Coiro & Dobler, 2007; Duke et al., 2006; Schmar-Dobler, 2003). Studies also show that online reading might require additional skills and strategies (e.g., Coiro, 2007; Leu et al., 2004; Wallace, Kupperman, Krajcik, & Soloway, 2000). Although instruction in information problem solving seems to be important for all students, some authors note that it may be particularly important for students with lower reading skills (e.g., Dreher et al., 1997). Coiro (2005) expresses a concern about struggling readers, noting that teachers should "pay a greater attention to readers struggling with making sense of online texts—or risk fostering inequities in electronic literacy" (p. 35). The ICT Panel (2002) extends the notion of inequity and divide beyond access to hardware, software, and networks to one that is created by limited literacy levels and a lack of the skills needed to make effective use of technologies.

Research with traditional printed texts shows that it is possible to teach elementary students, including those considered poor readers, to develop strategies for finding and using information (e.g., Dreher et al., 1997). However, virtually nothing is

known about students with LD and their online reading and interaction with the Web. Students with LD are increasingly educated in regular education classrooms (NCES, 2006). These students are often held to the same standards as their peers; yet, they have to overcome serious obstacles in their learning. The primary focus of this study is to investigate whether we can help the students with LD to overcome some of the obstacles in their learning with the Web through instruction in using the Big6 Skills in finding, using, and managing information for the purposes of writing informational texts.

Research Questions

This study aims to examine the outcomes of intervention with the Big6 Skills information problem solving approach to support students in their Web searches and report writing. An experimental pretest-posttest control group design used in this study involves two groups of seventh and eighth graders with LD who were matched on several variables (i.e. verbal and perceptual abilities, Internet skills, reading comprehension) and randomly assigned to the treatment and control group. The treatment group was instructed in the Big6 Skills approach to information problem solving, and both groups were instructed to use an Essay map as a visual organizer. In addition, a rating scale to assess students' motivation and prior knowledge was administered before each research topic. Research topics were related to social studies and science. The task called for the students to write reports for Social Studies and Science Fair posters to inform the fourth graders in their school about those topics. Finally, the treatment students were interviewed to gather qualitative data about their interaction with the Web and the Big6 Skills. The research questions include:

(a) Do students receiving the intervention with the Big6 Skills improve the quality of their written informational texts in comparison to the students not receiving the intervention?

(b) Do students receiving the intervention with the Big6 Skills increase the length of their written informational texts in comparison to those students not receiving the intervention?

(c) Do students receiving the intervention with the Big6 Skills increase the amount of information search they perform in comparison to those students not receiving the intervention?

(d) Do students receiving the intervention with the Big6 Skills exhibit greater metacognitive awareness about information problem solving at the conclusion of the study as opposed to the beginning of the study?

(e) Do students receiving the intervention with the Big6 Skills perceive any benefits in using the Big6 Skills approach to information search and management?

It was anticipated that: (a) students in the treatment condition would write qualitatively better expository texts; (b) students in the treatment condition would write longer expository texts; (c) students in the treatment group would navigate to more web pages to search for information; (d) students in the treatment group would increase in their metacognitive awareness related to their information problem solving; and (e) students would perceive instruction in information problem solving with the Big6 Skills as beneficial.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

In *School's out*, Perelman (1992) envisions a society where "teaching" and "learning" would be transformed to the point that education as such would not exist; there would be no schools and we would be involved in "hyperlearning" (p. 27). The environment for learning would be hypermedia with a number of links built into various texts. On the other hand, Negroponte (1995) portrays education as a static process, in which a teacher transported from the past across 150 years could continue on teaching right at the point where his colleague stopped. The present day situation in education seems to be neither as radical as the first vision portrays nor as inert as the second. Education has not radically changed as Perelman predicted; however, some changes are taking place. For example, reading and writing are still associated with print texts but are also increasingly associated with electronic texts, software, and networks. The question is not whether the machines will replace teachers, but how to support both teaching and learning with machines. School is not "out" and the changing nature of literacy practices demand that we develop curriculum and instruction related to electronic environments.

In this study, offline reading refers to reading printed texts, while online reading refers to reading electronic texts on the Web. The Web (the World Wide Web) is a system of interlinked electronic documents, known as hypertext. The Web is a service that can be accessed via computers connected to the Internet, a global network of interconnected computers. The focus in this study is on online reading on the Web and writing based on multiple electronic sources of information.

This literature review highlights some aspects of the changing nature of literacy practices with a focus on students in K-12 classrooms. The literature review is organized in six sections. The first section discusses epistemology from the perspective of electronic environments and new frameworks for learning, followed by the Web environment in the context of K-12 schooling in the second section. The third section presents selected theoretical approaches to reading and learning offline and research that examines these theoretical assumptions in empirical studies of online reading and learning. The fourth and the fifth sections present studies that specifically focus on K-12 students and the Web and students with LD and the Web, respectively. The review concludes with information problem solving and the Big6 Skills model in the sixth section.

Theoretical Framework

Electronic environments are characterized by hypertexts. Hyperlinks allow electronic texts to have "alterable surfaces" (Reinking, 1998, p. 20). In addition to these material features of hypertexts, some authors (e.g., Lankshear, Peters, & Knobel, 2000; Leu et al., 2004; Marshall, 2000) suggest that electronic texts are functionally distinct from print-based texts; reading electronic texts involves making sense of still and moving images, sounds, and words. This "information bricolage" creates possibilities for making meaning in different ways than print texts (Burnett in Burnett & Wilkinson, 2005, p. 158). For example, Lankshear et al. (2000) argue that information technology in general, and the Internet specifically, might "call for rethinking epistemology in a digital age" and

suggest "performative epistemology" using Wittgenstein's notion of knowing as "making, doing and acting" (p. 21).

Lankshear and colleagues suggest that "knowing" within spaces of ICT is different from "propositional knowledge of what already exists" (p. 36). Their account is based on the relation of knowing to "the mastery of a technique" (Wittgenstein, 2001, p.178) – knowing is viewed as an ability to perform; for example, how to make or make use of the links on the Web, how to use, learn, or program computer languages, or how to select, evaluate, or use information sources (p. 36). In *Philosophical Investigations* Wittgenstein (2001) illustrates instances of understanding and knowing in our everyday practices through exclamations: "Now I know how to go on!" and "Now I have it!" (pp. 89-90). Learning from this perspective is not only about content mastery but also about mastering and possessing a set of skills necessary to perform certain activities.

A common thread in the accounts discussed above is the notion that isolated pieces of information do not lead to the acquisition of knowledge and understanding. Spiro and Jehng (1990) use a metaphor of crisscrossing conceptual landscapes (after Wittgenstein), suggesting that knowledge that will be "used in many ways is taught in many ways" (p. 171). Similarly, Salomon and Perkins (1996) speak about a "network of connections" necessary for understanding to take place, advocate for "networking pedagogy", and also point out the importance of having a general knowledge of how to learn (pp. 117-125). In addition, Kozma (2000) suggests that we need to shift the focus of our research to instruction in tools that would enable students to take charge of their own learning.

In addition to the framework of performance knowledge, Lemke (1998) suggests that information technologies make possible "new paradigms for education and learning" and allow a shift toward learning that is interactive (p. 287). Within the paradigm of interactive learning, a teacher's task becomes helping children "learn how to learn" new technologies of literacy (Leu, 2002, p. 313). Salomon and Perkins (1996) also discuss learning for understanding as a "matter of performance acquisition", similar to motor skills but, in addition, extending to mastering patterns of thinking (pp. 116-117).

From the perspective of cognitive flexibility theory, Spiro and Jehng (1990) argue that electronic environments with hypertext may enhance comprehension by offering multiple perspectives from which to learn and situating information in different contexts. While hypertext designed with an educational intent may lead to enhanced learning (Spiro & Jehng, 1990), hypertext on the Web is not designed specifically with this purpose in mind. Nonetheless, the recommendation by Spiro (2002) to teach students to be prepared to deal with the changing world of life and work seems to be very important in view of the increasingly complex informational world in which we live.

Search for information—its location, selection, and organization—has always been an integral part of literacy education (e.g., Dreher, et al., 1997; Dreher & Sammons, 1994). While both online and offline reading may involve information search and its location, search engines demand more complex skills and knowledge for such tasks than looking in a table of contents or an index (Leu, Zawilinski, Castek, Banerjee, Housand, Liu, & O'Neil, 2006). Mikulecky and Kirkley (1998) describe increased literacy demands in many workplaces and argue that it is far more important to develop skills of actively and interactively accessing, analyzing, and applying information to solve problems than

being able to simply read and comprehend narrative texts or expository texts in textbooks. Changing workplace literacy demands and changing literacy practices call for new examinations of instruction in how to access, locate, manage, and communicate information.

The World Wide Web in the Context of K-12 Schooling

Similar to reading traditional texts in school-related assignments (e.g., textbooks), an interaction with the Web may involve reading for the purposes of recall of the text content, learning from the text, and a text search for a specific goal (e.g., write a report, give a presentation). In K-12 classrooms, students are often asked to read a print-based text and then answer specific questions or summarize information (Kintsch, 1994). Kintsch (1994) suggests that learning from a text, on the other hand, requires a deeper understanding that can be applied to new situations.

Text search, the focus of the present study, involves seeking information for "reading-to-do" tasks as opposed to "reading-to-learn" (e.g., Dreher, 1993; Guthrie & Mosenthal, 1987; Symons, MacLatchy-Gaudet, Stone, & Reynolds, 2001). Problem solving tasks such as an information or text search can hardly be performed without reading and may actually involve re-reading and "reinspection" of a text (Symons et al., 2001, p. 3). Inquires on the Web demand that students coordinate a number of activities that are more open in nature than reading informational text in a textbook followed by a specific set of questions. A Web-related task may start with an information search within hypertext, a text structure that may have a beginning point, but not necessarily a particular middle or end point. Students are expected to design their own paths in

constructing meaning. Therefore, reading in different media may involve different processes (e.g., Kozma, 1991).

While much progress has been accomplished in the area of offline reading (e.g., NICHD, 2000; RAND Reading Study Group, 2002), little is known about online reading of students in K-12 educational settings. Online reading on the Web constitutes a different environment for reading than printed texts in several aspects. First, the Web may be viewed as "global hypertext" (Bolter, 1998, p. 7), which includes not only interlinked texts but also images (including moving images), icons, and sounds. Because of its text organization and multimodality, hypertext creates new possibilities for meaning making (Reinking, 1998; Luke, 2003; Kress, 2003).

Second, hypertext may be viewed as a collection of signs to be interpreted through semiotic analysis as opposed to semantic analysis. Semiotics is seen as a counterpart to semantics (Ricoeur, 1976). While semantics has as a unit of analysis a sentence, semiotic analysis takes into consideration icon, index, and symbol, and the text is seen as a collection of signs to be interpreted (Kress, 2003; Myers, Hammett, & McKillop, 1998).

Third, hyperlinks (nodes) may function as icons and may also bear indexical functions as they lead to other texts. The interpretation of hyperlinks may complicate online reading because a reader may not know in advance whether the link will lead to something that is closely or only remotely related to the text on the screen. The non-linear nature of hypertext requires readers to decide what information to read and in what order, which may be difficult for readers new to a domain (e.g., Kozma, 1991).

Finally, reading online includes competencies of reading print text (e.g., Duke, Schmar-Dobler, & Zhang, 2006). However, emerging work on online reading suggests that hypertext might present material that is more difficult to read than printed material for both experienced and competent readers and less able readers (e.g., McEneaney, 2003). In addition, Leu, Kinzer, Coiro, and Cammack (2004) argue that what counts as literacy activities changes with the Web environment and consequently the strategies for comprehension and response also need to change. Yet, Ware and Warschauer (2005) argue that what counts as literacy in many of today's classrooms is still predominantly focused on mastering discrete skills with decontextualized print texts. It seems both urgent and important to investigate literacy practices and instruction within electronic environments (e.g., Coiro, Knobel, Lankshear, & Leu, 2008; McKenna, 1998; Mikulecky & Kirkley, 1998). Recent work (e.g., Coiro, 2007; Leu et al., 2006) shows that competencies required for successful interaction with offline environments might not be sufficient for successful interaction with online environments and that those readers who lack proficiency in both online and offline reading may be doubly disadvantaged. Students with LD in reading have difficulties in offline reading and online environments may compound their difficulties. The perspective that, for some students with LD, electronic environments may create further obstacles in their learning is of particular concern in this study.

Leu et al. (2006) note that reading on the Web typically involves reading expository rather than narrative texts. Leu and colleagues' case study of three seventh graders revealed that one highly proficient student offline was also highly proficient online, but also that one highly proficient offline student was low achieving in online

reading, and finally that one student with LD in reading was a much more efficient online reader than his peer who had no LD and was highly proficient in offline reading. An exploratory study that compared searches for information on the Web of three elementary education students and three elementary students with LD in reading showed great individual differences among the six students but also a need to support students with LD in their search, evaluation, management, and use of information (Curcic, 2005). One of the conclusions by Leu and colleagues (e.g., Leu, Coiro, Castek, Hartman, Henry & Reinking, in press) is that online reading is not isomorphic with offline reading. However, the ways online and offline reading overlap or differ are under-researched. The following section attempts to synthesize some of the theoretical and empirical work in this area.

Selected Theoretical and Empirical Studies: Approaches to Reading and Learning Offline and Online

In reading online as opposed to traditional print reading, one of the questions of interest is whether research on reading print text applies to reading hypertext. It should be noted that there is no single theory of reading, although there are several approaches to understanding reading processes (e.g., Gough & Hillinger, 1980; Just & Carpenter, 1992; Kintsch & van Dijk, 1978; LeBerge & Samuels, 1974). The discussion that follows is limited to the theoretical approaches of reading and learning that have been empirically examined in online environments.

Reading as text comprehension offline. Because reading online is not entirely different from reading offline texts, one may deduce that much of the model of text comprehension described by Kintsch and van Dijk (1978) applies to reading electronic

texts. Kintsch and van Dijk (1978) proposed a model of text comprehension that hypothesized that readers form both a micro representation of a text (linguistic text base) and macro representations of a text (situation model). The micro representation of a text involves the understanding of words, phrases, and sentences while macro processes are concerned with global understanding and overall ideas about the gist of the text (Kintsch & van Dijk, 1978; Kintsch & Yarbrough, 1982). In their early work, Kintsch and van Dijk (1978) assumed that "text comprehension is always controlled by a specific schema" (p. 373). They also recognized that in some situations the specific schema may not suffice and different schemata might be evoked. This model of text comprehension advances the understanding of reading because it draws attention to various processes involved in reading: we do not just decode words, but also form meaning about the gist of the text. However, this model does not completely explain how we proceed to integrate new information for which we may not have any developed schemata.

The concept of schema has been incorporated in some theories of reading comprehension (e.g., Anderson & Pearson, 1994) as an entity in memory in the form of previously stored knowledge, evoked as needed. Although Anderson and Pearson (1994) make a distinction between reading with the deliberate intention of learning information and reading a novel, for example, the problem of understanding how we come to comprehend new information (from an informational text or from a novel) remains. In considering the problems of bridging the gaps between prior knowledge and new information, an important concept is that of inference. Inferential activity, conceptualized by van der Broek (1994) as the constant fluctuation of activations which may be derived from background knowledge, or only *partially* (italics added) derived from background

knowledge, adds a dynamic component to the reading process and removes (or removes partially) the filling-of-the-slots perception of reading comprehension (cf. Anderson & Pearson, 1994, pp. 261-262).

Kintsch's (1998; 2005) later works stress the interaction of basic linguistic processing (construction) and knowledge integration, and he termed this model of reading comprehension the construction-integrationist (CI) model. Kintsch perceives text comprehension in the CI model as much more flexible than originally thought. He recognizes that there is no pure text-base because readers bring their own knowledge and experience to the situation model. The CI model, according to Kintsch (1998), involves processes interacting at many different levels (e.g., perceptual, syntactic, semantic, knowledge integration, and reasoning). The basic tenet of the CI model, however, is that readers use the words of the text to construct propositions. These propositions activate further propositions that are integrated into mental representations through the interplay of both bottom-up and top-down processes. Although in he offers a view of schema as a structure that is too tightly controlled and suggests that the CI model is much more flexible, Kintsch (2005) still asserts schema as a "powerful determinant" and as a "major constraint" that needs to be satisfied for a correct text interpretation (p. 127).

Some researchers argue that the schema concept has advanced classroom-based instruction in reading (e.g., McVee, Dunsmore, & Gavalek, 2005), but its usefulness has also been debated (e.g., Sadoski, Paivio, & Goetz, 1991). There are some attempts to revisit the schema theory and to reconsider schema as a "transactional" and "embodied" construct (McVee et al., 2005, p. 531), followed by the critiques of both schema theory and the attempts to reposition the schema construct within a socio-cultural perspective

(Krasny, Sadoski, & Paivio, 2007). McVee and colleagues draw attention to the socio-cultural origins of schema, while Krasny and colleagues perceive the very assumption of the schema existence as embodied a fallacy.

Bartlett (1995), associated with the concept of schema through his theory of remembering, discusses schema as a socio-cultural construct in origin. Bartlett argues that memories are personal but also carry tendencies of a social group. For instance, he gives an example of a herdsman in South Africa who remembered all the details in nine cattle transactions, together with cattle description, persons involved, and price, conducted one year earlier by his employer. Bartlett concludes that what a person remembers in detail might be of great interest to a particular social group that a person belongs to although not necessarily of great interest to that person.

Bartlett (1995) was well aware of the problems associated with the concept of schema. He considered using the concept of "active, developing patterns" in place of a "schema" but was equally unsatisfied with the term "patterns" (p. 201). In thinking about active and developing patterns, Bartlett seems closer to Kant's original thinking about schema as a process of, not only a product of, imagination (Kant, 1882; 1885). Therefore, the attempts to reposition and revise the concept of schema seem to address a problem that has been dealt with for quite some time, but not adequately resolved, especially in theorizing reading. As Bartlett hoped to advance our knowledge of mental representations based on memory, reading theorists hoped to use the concept of schema in reading to explain mental representations based on the interaction of the text with our prior knowledge. While Bartlett (1995) proposed that schema represents "an active organization of past reactions, or of experiences, which must always be supposed to be

operating in any well-adapted organic response", this dynamic aspect was lost in the theories of reading where schema seems to serve as a replacement for the concept of prior knowledge (p. 201).

Moving away from the concepts of patterns and schema as static, Spiro (2002) suggests that assembling prior knowledge and experiences, rather than retrieving them, better captures the ways people apply their knowledge to new situations, including reading. Spiro's line of thinking is closer to Bartlett's original thinking about reconstruction rather than the reproduction of past experiences. From the perspective of online reading and the structure of hypertext, Kintsch suggests thinking about how to hang new information on "hooks" in the long-term memory and to stimulate reader activity in this way (Kintsch, 1998, pp. 328-329). One of the questions posed by Kintsch (1998), "How does one create an active learner?" remains one of the central questions to the field of reading and education in general (p. 330).

Reading as text comprehension applied to online reading. The application of the Construction-Integrationist (CI) model to online comprehension (Salmerón, Cañas, Kintsch, & Fajardo, 2005) reveals that reader's strategies may play an important role in reading hypertext. Salmerón and colleagues hypothesized that because the text base representation consists of linguistic information drawn from the original text (as opposed to a macro structure), the number and the order of various links influences the information representation of the text base. They also noted that research with print text and hypertext with high and low knowledge readers has yielded heterogeneous results.

Salmerón and colleagues designed two experiments to test the hypothesis that the amount of information read by a reader affects the text base and that the order of reading

the text influences the situation model. Specifically, the researchers hypothesized that the number of nodes accessed influences mainly the construction of the text base whereas the transition between the nodes is critical for the construction of the situation model. Forty-one undergraduate students participated in the first experiment. The students read an expository hypertext (Flesh-Kincaid grade level = 12) about atmosphere pollution. The hypertext had 24 nodes (hyperlinks) and 3,855 words. Participants had to access the nodes by clicking on the titles provided in the overview of the hypertext.

The analysis took into account: coherence of the nodes (based on Latent Semantic Analysis), prior knowledge pre-test on eight true/false questions, 22 true/false text-based questions, cued association task (write down the first three concepts among 24 that first come to mind, these were later compared to an expert matrix), and 10 true/false inference questions that required participants to relate information from at least two nodes. The researchers used a quasi-experimental design with reading order and different nodes accessed as independent variables and text-based questions, cued association, and inference questions as dependent variables. Results showed the number of the nodes accessed significantly predicted the score on the text-based questions. Text-based scores increased as the number of nodes increased. A follow-up regression analysis of the two groups based on their prior knowledge revealed that the effect of node access was significant for low knowledge readers but not for high knowledge readers. None of the analyses showed significant results for the cued association scores or inference questions.

The second hypothesis tested was that reading order would influence comprehension. Three main patterns (linear order, top down path, and a combination of both) were identified. Participants following the linear order had better cued association

and inference scores than those following top-down path order and mixed order. To account for the possible prior knowledge effect, two ANOVAs were performed with prior knowledge as a covariate. Participants did not differ in prior knowledge; however, they differed on the number of the nodes accessed. The first group (linear order, top-down path) accessed more nodes and followed a more coherent path than the other two groups. Differences due to the reading order were based on two variables: nodes accessed and coherence between node transitions. In this experiment the reading order seemed to be independent of the prior knowledge of the reader but the authors could not make strong conclusions because of the limited number of participants per group. They therefore designed the second experiment.

In the second experiment, different overviews of the hypertext provided different coherent organization patterns of the text, based on the different position of links. The same hypertext was used as in Experiment 1 but two different overviews were developed: one had the highest coherence between transitions when reading from left to right and from top to bottom, while for the second overview the opposite was true (i.e., the reading order of the paths mentioned resulted in the lowest coherence).

Participants were grouped based on their prior knowledge and reading order as follows: low knowledge/low coherence (21 participants); low knowledge/high coherence (16); high knowledge/low coherence (11), and high knowledge/high coherence (19). The students with low knowledge benefited more from a high coherence order of the links, while the opposite was true for students with high knowledge. The dependent variables were scores on the text-based questions and on the cued association task. In Experiment 2, time was not limited to 20 minutes as in the first experiment; rather, participants could

decide how much time they would spend reading the hypertext. Correlation analysis showed no significant relationship between reading time and any of the comprehension variables.

In agreement with the previous experiment, the effects of knowledge and coherence did not appear when considering all participants without taking into account the reading order. The analysis that took into account the reading order (low and high coherence), showed that participants with low knowledge performed better on the cued association task when following a strategy leading to high coherence whereas the opposite was found for participants with high knowledge.

The experiments confirmed the hypothesis that the amount of information read influences the construction of the text-base while the reading order influences mainly the construction of the situation model. As the researchers themselves noted, this finding is not counterintuitive and may seem obvious. They nonetheless thought it was important to document how reading strategies influence hypertext comprehension because failure to control reading strategies may mask effects related to text characteristics.

It appears that the characteristics of learners as they relate to their reading strategies, their prior knowledge, and the hypertext design (in terms of coherence), influence online reading comprehension. Reading order leading to high text coherence might benefit students with low knowledge, while students with high knowledge might benefit from low text coherence. Teachers may benefit from this discussion when designing inquires on the Web by examining the hypertext structure prior to instruction, especially when teaching younger students with low prior knowledge. This line of research seems relevant for intentionally designed hypertext for K-12.

Based on the works of Kintsch and van Dijk (1978) on text comprehension and Guthrie's (1988) model on locating information in documents, Protopsaltis and Bouki (2005) proposed a hypertext reading model. The model contains eleven components: (1) establish a goal or task, (2) scan the categories of information, (3) read the categories, (4) build the text base, (5) build the situation-model, (6) use appropriate strategy, (7) monitor, (8) follow the appropriate path, (9) repeat as many time as necessary, (10) accomplish goal, and (11) recycle if you fail. Through think-aloud protocols, 22 undergraduate students verbalized their thoughts as they read hypertext about economics (with no prior courses taken in economics). Subjects were randomly assigned to three conditions: read to answer specific questions, read to answer general questions, and read with no instruction. Each session lasted about one hour. The analyses revealed that there were no significant differences in comprehension based on different reading goals.

Similar to findings in the Salmerón et al. (2005) study, the transcripts revealed three navigational strategies: linear or serial (subjects followed the links in the order of their presentation), mixed (subjects chose some links in linear fashion but some in random fashion) and a mixed review, in which the subjects first scanned the document to see what was available, and then proceeded in the mixed strategy manner. The majority of the readers followed the linear fashion, perhaps borrowing a strategy from offline reading. Another factor that influenced the reader's choice was personal interest. Through the analysis of the verbal think-aloud protocols, it was clear that some participants chose links based on their personal interests. For example, one participant reported: "I click on New Zealand, I am from New Zealand, that's why I pick New Zealand"; or, another similar explanation was given for choosing another link related to Australia: "Sorry, I am

just curious about Australia, because that's where I am from"; or, "...reading each title in terms if anything grabs my interest" (Protopsaltis & Bouki, 2005, p.165). The authors concluded that there is a need for more systematic focus on interest and motivation in reading in general and in hypertext environments in particular.

Based on the work on text comprehension and hypertext reading, it appears to be important to control for prior knowledge, navigational patterns, and motivation. It seems that high knowledge learners engaged in opening a number of links form a solid text-base and a situation model. The research suggests that motivation is also a variable that should be controlled in studies on hypertext.

The role of working memory (WM) in reading. Long- (LWM) and short-term working memory (WM) have been studied as integral to the processes of reading and learning. One of the most influential models of memory has been advanced by Baddeley (e.g., Baddeley, 1998; Baddeley, 2000; Badelley et al., 1985). Baddeley's original model consisted of a central executive component, a phonological loop (processing verbal speech input), and a visual-spatial sketchpad (assumed to be capable of manipulating visual and spatial input). The central executive processes seem to be involved whenever stored information needs to be manipulated, integrated or involved in some other more complex processes than simple representation and maintenance (Repovš & Baddeley, 2006). Baddeley (2000) also included an "episodic buffer" in his revised model, which serves to temporarily store information held in a multimodal system and to connect information from the short-term storage and from long-term memory into integrated representations or episodes.

Several studies indicate that students with reading difficulties may lack the ability to retain information in memory while processing the same or new information (e.g., Swanson, 1999). Swanson, Trainin, Necoechea, and Hammill (2003) note that the ability to temporarily retain information while processing other incoming information is a skill critical to many reading activities. This skill may be particularly important for hypertext reading in view of its multimodality.

WM processing applied to online reading. Wenger and Payne (1996) started their considerations of processing hypertext based on studies of individual readers' performance that go beyond traditional reading to include performance on other cognitive tasks (e.g., memory span or speed of accessing the meaning of words in memory). They predicted that if there was any relationship between the performance on the working memory span tasks and performance while reading hypertext, it would show up in the traditional measures of reading performance. The authors also considered spatial-relational processing as important in reading hypertext, but not necessarily in printed text. They hypothesized that if this indeed is the case, this would be shown through the memory for relational structure and efficiency of hypertext use (as indexed by the repeated number of nodes). The latter considerations were supported by their earlier work.

Their study is of particular relevance to the present study because they investigated the processes that support comprehension and retention of hypertext information and the possible ways in which these processes would differ from those involved in the comprehension and retention of traditional text. The tasks implemented in this study therefore included those tasks that have been predictive of traditional reading

performance but also those that could potentially reveal a relationship between spatial and relational abilities while reading hypertext. All the tasks were presented on the computer screen. Each session lasted about one hour and assessed traditional reading comprehension and hypertext comprehension. The study was correlational in design and conducted with 22 undergraduate students. Hypertext was drawn from scientific and technical publications with minor revisions for length. Texts were segmented into nodes and each node was assigned a short title based on the first sentence of the paragraph.

For the working memory span task in traditional reading, subjects read declarative sentences, 13-16 words in length, in sets of two sentences. They were prompted to verbally recall the final word in each sentence. The number of sentences in each set then increased in increments after the students recalled 100% of the final words of the sentences for the set size three times.

For the lexical decision tasks, 80 words, 80 pseudohomophones, and 80 nonhomophonic nonwords were used as stimuli; all were single-syllable items. From this pool, 16 words and 8 nonwords were randomly selected and presented on the screen. Subjects had to decide whether the item presented was a word or a nonword. Studies of performance on lexical decision tasks have been consistently related to reading performance in both adults and children (e. g., Baddeley et al. 1985). However, results from studies with nonword homophones have demonstrated that performance on certain types of nonword homophones (e.g., froot is a nonword homophone of fruit) may be related to other measures of information processing ability, but not related to reading comprehension (e.g., Baddeley et al., 1985). Wenger and Payne predicted that if reading hypertext relies on the types of information processing tapped by lexical decision tasks in

the same manner as reading printed text, then there would be a relationship between lexical decision task performance and performance while reading.

For the relational task, students had to match the letters either in "physical match" or "name match" from a pool of 80 pairs of letters. Two types of decision rules are typically used with this task: the first is a name match rule, which specifies that a match response should be made when the two letters have the same name (e.g., A and A or A and a); and the second is a physical match rule, which specifies that a match response should be made only when the letters have the same name and are presented in the same case (e.g., A and A or a and a). Studies using the letter matching task have shown that performance with the name match rule is highly related to reading while performance with the physical match rule is not (Baddeley et al., 1985). Finally, for the spatial processing task, the subjects judged whether two bar histograms were the same, with one presented vertically on the screen and the other one rotated at a 0-, 90-, 180-, or 270-degree rotation.

To assess the hypertext reading, the subjects were given two minutes to write down as many node titles as they could remember after reading each hypertext, followed by responding to 10 multiple-choice comprehension questions (each with four alternatives). Finally, they were presented with 15 pairs of node titles and were asked to identify whether these nodes were linked or not in the text they had just read. This final task probed subjects' recall of hypertext structure.

The authors concluded that the two patterns of data in their findings allowed straightforward conclusions. The relationships between the information processing measures and the hypertext reading measures replicated those documented between

information processing measures and print reading. For example, choice reaction times were related only to reading rate, while reading rate was not systematically related to the other measures of reading performance. The name match for the letters was positively related to both recall and comprehension. Lexical decisions based on words and nonwords were related to response time: a shorter response time and a higher-level accuracy were related to higher reading rates and fewer repeated nodes (indicating the efficiency of hypertext use). For lexical decisions involving nonwords, there was one significant result—higher levels of accuracy were associated with higher reading rates. The implications of the first pattern of findings are that applied research on print reading could guide hypertext reading. However, there was no significant correlation between the measure of working memory and any of the measures of reading performance.

The second set of findings relates to the relationship between the spatial processing task and hypertext reading. Faster response time was associated with higher reading speed and better comprehension. Higher level of accuracy on the spatial processing task was associated with better comprehension, better retention of text structure, and fewer repeated nodes (i.e., going back to the text in the hypertext). The authors suggest that the relationship between spatial processing and measures of reading hypertext are of critical importance because these skills may advantage or disadvantage some readers. The second pattern confirms the findings about the importance of navigational patterns of readers. Because faster response is associated with reading speed and better comprehension, it may be expected that students with LD in reading may need more time in completing their tasks. However, the finding that the efficiency of hypertext use (as indexed by the number of repeated nodes) and memory relational structures may

also contribute to hypertext reading, indicates that instruction in navigational skills may be of particular importance for students with LD in K-12.

Dual-coding theory. A line of research that departs from the schema approach to reading is that pursued by Krasny, Sadoski, and Paivio (2007), who propose a different approach to mental representations conceptualized as a dual coding theory (DCT). Paivio and colleagues object to granting schema a form and substance and suggest that mental representations are formed through language (linguistic code) and imagery (nonlinguistic code) (Paivio, 2007; Sadoski, Paivio, & Goetz, 1991). These two codes are viewed as separate but interconnected. The DCT proposes that images evoke both a perceptual code and a verbal code in memory (which is why, they note, visuals enhance learning). It should be noted that these researchers do not limit mental images to visual, but also include auditory, haptic, and affective modalities (which is why the term "dual" in the "dual coding theory" might be misleading). The DCT critiques the CI model as relying on only amodal propositions in text encoding (Sadoski, 1999). Kintsch (1988) indeed noted that it would be desirable to include in the CI model nonpropositional representations (e.g., spatial-visual representations).

Dual-coding theory applied to online reading and learning. Mayer (2008) proposes that multimedia literacy is based on the dual-coding assumptions: in essence, he suggests that people understand more with pictures and words than with pictures alone. Mayer and colleagues confirmed this hypothesis through nine out of nine experiments with university students studying scientific explanations. The median effect size was 1.50, considered a large effect. Further, in 21 separate tests, students performed better in a transfer text when they learned from pictures and spoken texts than from pictures and

printed text. The median effect size was 0.97, also considered large. Mayer (2008) argues that the format in which the word is presented matters; printed words compete with pictures for visual processing.

Elaborating on dual-channel assumptions, Mayer and Moreno (2003) proposed a theory of multimodal learning, where in addition to suggesting two separate information-processing channels for verbal and visual material, they also stress limitations of cognitive capacity and active processing as important in multimedia learning. Briefly, if learners pay attention, some of the words and pictures enter working memory and are further processed. The resulting verbal and pictorial representations are integrated with each other and with relevant prior knowledge from long-term memory. Verbal and visual channels have a limited amount of processing capacity available, while learning requires substantial cognitive processing in both channels. Mayer and Moreno (2003) propose ways to reduce cognitive load in multimedia learning, which has relevance for the design of multimedia instruction (see Table 3 in Mayer & Moreno [2003] for a description of related experiments and effect sizes, p. 46).

Some of the limitations of Mayer's line of research were noted by Dalton and Proctor (2008). They suggest that laboratory-based experiments in which college students view a 30-second animation and are then tested for comprehension may not apply to students' inquiries or in-depth learning, and may not hold true for K-12 students. It seems therefore important to extend the research to students in K-12 settings.

From the perspective of reading hypertext on the Web, it seems important to note that in this environment icons function as symbols that stand for something else (see the screenshot and its description on page 6). The Web brings another code to be broken: that

of a symbol that may also function as a hyperlink. This dual meaning of some icons may complicate the reading of hypertext, especially for younger readers. For example, if an elementary student sees an icon that represents a computer, this young reader may guess that this icon might bring him to a game rather than to an article about energy. Icons are numerous and sometimes idiosyncratic (e.g., reflecting the Web-author[s]' semiotic understandings). Consequently, prior knowledge might not necessarily offer an adequate understanding of icons. Virtually nothing is known about students' reading of icons on the Web. Semiotic perspectives of reading may lead to a better understanding of reading hypertext. Some researchers (e.g., Kress, 2003; Kress & van Leeuwen, 2006) suggest adopting a semiotic and visual approach to literacy as opposed to linguistic and this body of work is discussed next.

Semiotic literacy model. Modality considerations, especially as they relate to texts and hypertexts, are examined in the line of research that aims to reframe the theorizing of reading within a semiotic framework. Kress and van Leeuwen (2006) distinguish visual and verbal structures as two modes that can be used to express meanings but do not view them as simply alternative means of representing "the same thing" (p. 76). As these authors adopt a semiotic rather than a linguistic approach to reading, they stress the multimodality of texts. Kress and van Leeuwen (2006) note that written texts involve more than language—material (e.g., paper or metal), layout (e.g., on a page or a computer screen), and medium of writing (e.g., dots of ink or pixels), just as spoken "text" is visual (e.g., accompanied by gestures and facial expressions), and not just verbal. The "anchor" for a message may be an image rather than the written text when both are represented on a page or a screen (Kress & van Leeuwen, 2006, p. 43).

Kress and van Leeuwen (2006) extend their semiotic approach to literacy to work on the grammar of visual design as an attempt to address reading images and to build a visual literacy theory as a complement to a theory of language. In addition, these authors draw attention to affective aspects of human practices as not being separate from other cognitive activities, a point also stressed by the proponents of the dual coding theory (e.g., Sadoski, 1999).

Semiotic literacy model applied. The application of a visual literacy model and communication as sign production and interpretation has been called *a multimodal social semiotic approach* to learning (Stein, 2008, p. 875; Kress, Jewitt, Ogborn, & Tsatsarelis, 2001). Studies conducted from that perspective often employ qualitative design. For example, Ware and Warschauer (2005) adopted semiotic as well as linguistic analysis of multimedia texts produced by youth in two programs: DUSTY, an afterschool program, and a laptop initiative in one school district in California. The analyses of students' texts revealed some commonalities across multimedia texts produced and included frequent mixing of visual, graphic, linguistic, and other semiotic modes. Linguistically, students tended to write in a limited amount of syntactically complex sentences as their writing was akin to their oral language.

Through their case studies, Ware and Warschauer (2005) describe youth involved in innovative literacy practices. For example, one nine-year old student excelled in the genre of digital stories in which she blended sound, voiceover, printed text, image, and video. She demonstrated a strong sense of audience awareness: "The more details, the better the story is going to be, and the other people are going to be so interested in your movie..." (p. 437). The story was about her visit to the zoo and a baby tiger that escaped

through her legs. In building a portrait of her main character, the tiger, she combined different modes: to the linguistic text mode she added a voiceover to describe the tiger as "so smart because he knew where all the animals were..." and to suggest even further how smart he was she enhanced his image with a cap and diploma (p. 437).

The authors also describe third and fourth graders equipped with laptops, wireless high-speed Internet access, and multiple software programs for a task to prepare second graders for their statewide math exam. Students developed a direction booklet and digital videos with explanations to create age-appropriate instructional materials. Such multimodal pedagogy is meant to draw students into academic projects and to bridge an often perceived disconnect between the literacy practices that students engage in and outside school. As the authors themselves noted, we know very little about the transfer of multimodal texts and projects into conventional literacy. At the same time, it should also be noted that conventional literacy as it is tested on statewide exams does not capture the skills needed for 21st century life and work (e.g., McKenna, 1998; Mikulecky, & Kirkley, 1998; Ware & Warschauer, 2005).

New literacies and reading. Although reading online does not occupy a central place in reading instruction today, it will undoubtedly occupy an increasingly more important role in view of the fact that changing contexts for reading are here to stay (e.g., reading on the Web). New literacies imply new social practices created through the use of technologies in which skills, strategies, and dispositions that are associated with offline reading do not necessarily coincide completely with those of online reading (Coiro, 2007; Leu, Zawalinski, Castek, Banerjee, Housand, Liu, & O'Neil, 2006). As new technologies emerge, the nature of literacy changes. Coiro et al. (2008) advocate bringing a set of

multiple perspectives to the development of understanding of new literacies. Coiro and colleagues also advocate for treating the Web as a distinctive context for literacy rather than imposing theoretical frameworks from other contexts and perspectives. Their stance is of particular relevance to the present study in which the context for reading and learning is situated on the Web.

The prerequisites for successful offline reading may not hold true for online reading. For example, Coiro (2007) suggests that, traditionally, we might predict that the lower levels of prior knowledge would impede comprehension, but the findings of her study described in the next section indicate that this is not necessarily the case in online reading.

New literacies applied to online reading. Coiro (2007) investigated the extent to which new reading comprehension skills and strategies may be required on the Internet. The sample included 109 seventh graders of various ethnic backgrounds and reading achievement levels. An Online Reading Comprehension Assessment (ORCA) with Scenarios I and II was designed so that the students could learn more about the respiratory system and the dangers of carbon monoxide poisoning. Tasks included: (a) locating, (b) evaluating, (c) synthesizing, and (d) communicating information online using the Internet (to two fictitious treasure hunt creators).

Three independent variables were entered in the following order: offline reading comprehension ability, prior knowledge, and online reading comprehension ability (ORCA-Scenario I). Results of a hierarchical regression analysis indicated performance on one measure of online reading comprehension ability (ORCA-Scenario I) accounted for a significant amount of variance (57.9%) in performance on a second measure of

online reading comprehension ability (ORCA-Scenario II) over and above offline reading comprehension ability and a measure of topic-specific knowledge (in that order). There was no significant interaction between offline reading comprehension and prior knowledge and no significant interaction between offline reading comprehension and the first measure of online reading comprehension (ORCA-Scenario I). However, there was an interaction between prior knowledge and online reading comprehension ability. Further analysis through simple regression repeated with each new variable indicated that (a) among students who have *high* levels of online reading comprehension skills (as measured by performance on ORCA-Scenario I), prior knowledge did not appear to significantly affect performance on ORCA-Scenario II; (b) among students with *average* levels of online reading comprehension skills on ORCA-Scenario I, prior knowledge did not appear to significantly affect performance on ORCA-Scenario II although it approached significance; and c) among students with *low* levels of online reading comprehension skills on ORCA-Scenario I, prior knowledge had a positive and significant effect on performance on ORCA-Scenario II. Coiro concluded that higher levels of online reading comprehension skills might help compensate for lower levels of prior knowledge in online reading environments when students are required to locate, critically evaluate, synthesize, and communicate information from the Internet.

Coiro (2007) then focused on three students who read at different levels of online proficiency and had different offline reading achievement to explore the nature of online reading comprehension through retrospective think-aloud protocols. It appeared that low-knowledge students with high online reading skills were able to use the Internet to quickly locate the background information they needed and then to proceed with the

online reading task. On the other hand, Coiro suggests that some high-knowledge readers might not be able to take advantage of additional learning opportunities simply because they may lack the online skills to locate information in the first place. Readers with both low prior knowledge and low online reading ability might struggle even more in the networked contexts. Coiro concluded that if these findings were to be sustained in additional work, this could be cause for much concern among readers with lower online reading comprehension skills. The Coiro study complicates research findings that seem to imply that offline reading competencies will predict online reading competencies. The present study, which controls for both offline and online reading competencies, may be informative in that respect.

Cognitive flexibility theory. Spiro and Jehng (1990) advocate teaching and learning with computers. Complex concepts and subject matter are viewed as ill-structured domains, which require cognitive flexibility in learning. By "cognitive flexibility," Spiro and Jehng mean the "ability to spontaneously restructure one's knowledge, in many ways, in adaptive response to radically changing situational demands (both within and across knowledge application situations)" (p. 165). Although this theory is not a reading theory but rather a theory of knowledge acquisition and application, it also includes some aspects of reading as a prerequisite to knowledge acquisition and text interpretation within the hypertext environment.

Hypertext in the studies of Spiro and colleagues (e.g., Feltovich, Spiro, & Coulson, 1989; Spiro, Coulson, Feltovich, & Anderson, 1988; Spiro & Jehng, 1990; Spiro, Feltovich, Jacobson, & Coulson, 1991) stands for intentionally designed texts that are created as multidimensional and Web-like in structure. Because texts are

multidimensional, they may support multiple interpretations. Learners should be nonetheless be encouraged to support their claims with evidence rather than offering interpretations without warrant. Reading in this account is tied to forming mental representations of text through assembling rather than retrieving schema, or background knowledge and experiences. The structure of hypertext, with different paths built into it, offers the possibility to explore concepts and topics through the construction (along different paths) of multiple texts. Multiple representations promote flexible thinking because information is presented and re-presented in different contexts.

The basic premise of intentionally structured hypertext can only partially apply to the Web environment which is not intentionally designed to support learning. However, the cognitive flexibility theory forces us to consider how different environments for reading and learning (e.g., linear versus multidimensional texts) may offer different learning experiences, and may also require and foster different skills and patterns of thinking (Spiro, 2002). How offline and online environments may impact learning is described next.

Cognitive flexibility theory applied: Reading on the Web versus in the library. A study by Roy, Taylor, and Chi (2003) illustrates how different strategies for reading hypertext and different contexts for learning (the Web and the library) may result in different knowledge gains. Roy and colleagues conducted a study with 28 eighth graders and examined how students learned specific information when performing online searches on the Web as opposed to offline searches in the library. The target domain was a "mosquito-hunting behavior" (i.e., how mosquitoes find their prey) and students' learning was assessed through a pretest and posttest. There was no significant difference

on the pretest in target knowledge, but there was a significant difference on the posttest regardless of the condition (the Web or the library) or gender.

Students in the Web condition demonstrated larger knowledge gains than those in the library condition, although the difference was not statistically significant. On the other hand, the knowledge scores on target-related information (as opposed to target-specific) were greater in the library condition. One of the conclusions of the study was that the Web might be an efficient means for searching and finding information for a well-defined set of information, but that the library may provide for more elaborate and contextual information. In addition, boys, who scanned through many document excerpts on the Web, performed better in the allotted time than girls, who actually opened and thoroughly browsed through some of the linked documents. The authors suggested that girls could benefit from instruction in more efficient searches for information (a point to be noted here is that the tasks were performed within specific time constraints).

It seems that information search conducted on the Web versus in the library may create different contexts that differ not only in modality (online versus offline) but also in the types of search for information (scanning versus browsing). The search for information on the Web with a specific focus on K-12 students is discussed in the next two major sections.

Summary. The findings of a number of studies that examined online and offline reading demonstrate some similarities and some differences between the two processes. For example, reading ability, skills, and strategies might influence text comprehension both in reading offline printed texts and reading online hypertexts. However, the very concept of text changes with online reading. The number and the order of the hyperlinks

accessed may lead to various texts and, ultimately, to various text constructions. The navigational paths might vary with interest and motivation.

Prior knowledge might influence text construction and aid comprehension, as well as the skills in navigation of hypertext. It seems that readers with low prior knowledge and low online reading skills might struggle in online reading comprehension, while high online reading skills might mediate poor reading skills. The efficiency of hypertext use (as indexed by the number of opened and repeated hyperlinks) may also contribute to hypertext reading and comprehension, which indicates that instruction in navigation is an important consideration in information problem solving on the Web.

Earlier approaches to offline reading (e.g., Rosenblatt, 1978) have already suggested that a reader and a text are in a transactional relationship. Online reading seems to add layers to that perspective for several reasons: (1) interactivity is built into online electronic texts such as hypertexts, adding to transactional planes; (2) links may lead to texts that are written by different authors; (3) the interpretation of visual stimuli may aid the construction of meaning but it also may distract reading, especially if one engages in navigation within and across texts; (4) critical reading pertains to detecting and evaluating relevant information but also ignoring irrelevant information (unrelated pop-ups, ads, etc.); and (5) decoding words, as well as icons, seems to be a prerequisite to creating a "micro" model during reading, while a new set of strategies may be needed to create a "macro" level of text understanding.

K-12 Students and the World Wide Web

A body of literature on children's searches for information on the Web has been rapidly growing within the last decade (Kuiper et al., 2005). Children increasingly use the

Web as an information resource for school assignments (Eagleton, Guinee, & Langlais, 2003; Jackson, 1996). Lyons, Hoffman, Krajcik, and Soloway (1997) point out some advantages of using the Web in classroom inquiries: (a) students have access to current content which may be presented in a dynamic form (video/sound/text) and therefore may be more attractive than a textbook; (b) a computer offers immediate access to primary source materials; and (c) online publishing and collaboration may increase student motivation.

There are many Web pages designed with K-12 users in mind; however, the Web was not designed originally for use in K-12 classrooms, and children have to learn how to navigate it. Studies show that students need help in the process of learning how to navigate the Web. For example, Lyons et al. (1997), who observed two pairs of middle and high school students, found that the choice of keywords, spellings, and the use of Boolean searches (e.g., using a string of search words) caused many problems with the students' Web searches during science inquiries. On the other hand, students may search for information with logical key words spelled correctly, for example "tornadoes", without finding information about the specific mechanics of tornadoes (Lyons et al., 1997, p. 20). The same study showed that a pair of middle school students spent four days searching for information on a hydrologic cycle, and in the end, resorted to the library. Although both pairs of students had access to "places to start", the start pages created by librarians, the students went directly to the search engines.

Studies also reveal that the use of information may be problematic even when students have developed adequate technological skills (e.g., Hoffman, Krajcik, & Soloway, 2003; Wallace, Kupperman, Krajcik, & Soloway, 2000). For example, students

may search and collect information, but not really consider how they will eventually use the information to answer their questions. Also, students sometimes change their topic or question if they cannot find the precise information they are looking for (Fidel et al., 1999; Wallace et al., 2000). This strategy also has been observed with searches for information within traditional texts (e.g., Dreher, 1994).

Pifarrè, Gòdia, and Martorell (2006) found out that students do not change and adapt their search strategies based on different tasks. The authors asked sixty-eight 13- and 14-year-students to perform three different tasks focused on the planet Mars. The first was a "fact-finding task" (search for specific data), the second was a "search and select general information task" (students were asked to synthesize information), and the third was a "give opinion and arguments" task (students were asked to support their opinion regarding evidence supporting past life on Mars and the possibility of future human colonies on Mars). Students were much more successful on fact-finding tasks than on the other two tasks which required selection and re-organization of information. Although the other two tasks were clearly more elaborate, the authors noted that students did not alter their search strategies to the different task demands. One of the authors' recommendations for instructional design was to develop scaffolded instructional activities to support and develop more effective Internet searches and strategies for information problem solving tasks.

In contrast, Schacter, Chung, and Dorr (1998) concluded on the basis of an experimental study with 32 fifth and sixth graders that children were more successful with open-ended tasks than fact-finding tasks. The students were given two tasks, one "well defined" (e.g., What are the three types of crime that happen most in California?)

and one "ill defined" (e.g., What should be done to reduce crime in California?). Students were far more successful with the ill-defined tasks than with the well-defined tasks. For example, only two out of 32 children found information to respond to the well-defined task. On the other hand, 30 out of 32 students found information to respond to ill-defined task. The authors concluded that searching for precise, concrete information makes high demands on search strategies. Vague tasks seemed to be more suitable for browsing, preferred by these students, to keyword searches. An ill-defined task also implies that there are more potential correct answers. These contrasting findings suggest that the type of task in itself is not sufficient for predicting students' performance. It is also possible that students in Schacter et al.'s (1998) study were more knowledgeable about the topic of crime in their state (e.g., through TV) and were able to apply prior knowledge to the topic, as opposed to the topic of life on Mars, which is based much more on conjecture. The students might also have been more motivated to investigate a topic related to their lives.

Another study that examined searching for information was performed by Bilal (2002). She constructed searches around three different tasks, fact-finding, research-oriented, and self-generated, with 22 seventh graders from three science classes. The method provided empirical data about student searches for information in Yahooligans! search engine. Bilal recorded cursor movements, including clicking and scrolling, with the Lotus ScreenCam (http://www.lotus.com), a Windows-based software package that records, saves, and replays cursor movements. Exit interviews revealed that most children (87%) enjoyed Yahooligans! search engine due to ease of use, ability to perform keyword searching, ability to visit different Web sites, availability of graphics, and fun.

The findings indicated that 50% of students were successful on the fact-finding task, 69% succeeded "partially" on the research-oriented task, and 73% were successful on the self-generated task. The high percentage of success on the self-generated task was possibly related to the students' increased motivation as they chose the topic of their own interest but possibly also due to the simplicity of some of the chosen topics. In addition, students received assistance from the researcher and media specialist in narrowing down topics, which also might have contributed to the students' success on self-generated tasks.

In a study by Fidel et al. (1999), observations of 8 high school student volunteers on their searches for information on various topics showed that students did not adjust their search behavior to take into account a new task. Students tended to rely on their past successful experiences in selecting Web sites. Although this approach might seem reasonable, it also led some students in this study to search for information on inadequate sites. For example, Fidel and colleagues noted that a student searched for horticultural information about a plant (new assignment) within the URL of a daily local newspaper given for the previous assignment. Students in this study were glad to be told "where to start searching", in other words, the best words to use in the search box (p. 28). Students valued the speed with which they could find information. Yet, students also felt frustrated if the Web did not produce results quickly enough. Nevertheless, a number of studies show that most students like using the Web despite the problems they may encounter (e.g., Fidel et al. 1999; Large & Beheshti, 2000; Ng & Gunstone, 2002).

Wallace, Kupperman, Krajcik, and Soloway (2000), during their observation of 8 middle school students working in pairs on a six-week ecology unit, noted that students did not seem to know how to broaden or narrow their searches. Students heard the terms

such as "narrowing" or "broadening" the search during instruction and mentioned these terms while performing searches, but kept using the same keywords in practice. In addition, Wallace and colleagues noted a tendency of students to search for concrete and ostensibly "right" answers.

Studies reveal that students tend to decide on the choices of Web sites based on specific titles without reading the descriptions (Kafai & Bates, 1997; Lyons et al., 1997). This strategy may limit information sources and, consequently, the information acquired. Students' prior knowledge of both the task and the domain is considered to be one of the factors influencing the search results (e.g., Fidel et al., 1999). It seems that prior knowledge makes it easier to formulate adequate keywords and to evaluate information (e.g., Hirsh, 1999).

Although some studies (e.g., Fidel et al., 1999; Marchionini, 1989) found that older elementary children were more successful in their searches than younger children, Solomon (1994) suggests that instruction and the curriculum (e.g., integrated language arts curriculum) might be more influential than the grade level. In his study, the sophistication of the fifth graders' strategies with the Online Public Access Catalog (OPAC) was found to be less impressive than that of children in lower grades, which he related to the curriculum and instruction (Solomon, 1994). Solomon's study employed a naturalistic design as he observed almost 500 children in a library over a year, during 35 observations each lasting a school day. The fifth graders were given clear-cut assignments by the teachers who mostly followed traditional subject-centered curriculum (e.g., "Turn in a written report with the following pieces of information on your state."). The assignments were oriented to fact finding without emphasis on the application of

facts or critical thinking. While the success rate for fifth graders was high, they were less able to recognize and respond to breakdowns in their searches than younger students (first through fourth graders). Younger students were given more open-ended assignments such as a report on a planet or an animal of choice. Various habitats and foods of particular animals were then talked about in the classroom, in addition to writing about them. Eight percent of the students had LD. Their performance did not differ from the rest of the student population. This study seems to add an important aspect to information search studies because it indirectly points to the fact that students develop habits of mind through the curriculum and instruction that they also bring to the area of information searches.

Studies by Wolf, Brush, and Saye (2003) and Herring (2006) found that specific models, such as the Big6 Skills and PLUS (Purpose, Location, Use, and Self-evaluation), were useful for students' research assignments. The Big6 Skills approach is often used in the U. S. schools, while the PLUS model has been used by schools in the U.K., South Africa, Australia, and New Zealand.

Wolf and colleagues (2003) implemented the Big6 Skills with 18 eighth-grade students during a social studies project. The authors sought to discover what effects the Big6 Skills model might have on the metacognitive skills of the students. The students' task was to search for information and write a one-page newspaper article about events surrounding the Civil Rights movement, with a focus on the Selma March. One of the researchers acted as participant-observer during the study. The classroom teacher provided support for non-instructional issues as they arose during the study. The content of the African-American civil rights movement had not previously been addressed in the

curriculum. Also, the journalistic style of writing was not a format previously assigned by the classroom teacher. Therefore, the prompts were designed to support students in their search for the information needed for newspaper articles: people involved, goals of the people involved, causes of the event, description of what happened, opinions and quotes in favor of and opposed to the event. The study was conducted over twelve 85-minute sessions.

Data were collected through a tracking feature that recorded students' navigation paths, a response journal to open-ended questions posed after each session, exit interviews, and students' graded (using a rubric) papers. The rubric used to grade the students' papers was developed in consultation with the classroom teacher and included steps needed to complete the article (task analysis), locating and obtaining information from the database (location and access), applying information to the sections of the article (use of information), and synthesizing the information into a final product (synthesis). Two neutral scorers assessed each newspaper article using the scoring rubric with inter-rater reliability of .91. Despite little direct instruction about writing newspaper-style articles, most articles contained information pertaining to the five Ws (who, what, where, when, and why). Some of the articles exceeded the one-page requirement set by the investigators. Wolf and colleagues suggest that the Big6 Skills enhanced the level of engagement the students had with both the content and their writing. Using qualitative analysis, the written artifacts, journals, and exit interviews revealed that students benefited from implementing the Big6 Skills in their search and extraction of information. Although the teacher was skeptical that students could write a successful newspaper article without an adult acting as an editor, students' work fulfilled the

requirements of the task (one-page newspaper article), which was a new task to them. Wolf and colleagues (2003) advocate for the Big6 Skill approach as a "general scaffold" as opposed to a "situation-specific scaffold" that students have to rely on each time they encounter a problem because "such specific-target scaffolds may support only one portion of the metacognitive spectrum of skills" (p. 8). Indeed, journals and interviews revealed that some students viewed the Big6 Skills to be useful for other subjects, such as English, in addition to history inquires.

Similarly, Herring (2006) reported that the PLUS model provided students with a scaffold for school research assignments. The PLUS model consists of a booklet that provides guidance for completing an assignment. Students were introduced to the PLUS model in the library. Questionnaires revealed that, out of 52 students, 24 answered positively, stating that the booklet guide was beneficial to them; 18 students made no response and therefore it is not clear whether they used the booklet or not; 5 students answered positively but also included a negative aspect to their response; and 5 students stated that they did not use the booklet.

Those students who responded positively acknowledged that the booklet kept them on track, helped them to plan ahead, and made the process easier because it "divides research into stages and this makes it easier when you write it up", and "it's useful—it helps you with skimming and scanning and this saves you time" (Herring, 2006, p. 15). The responses also showed that 60% of students preferred to use Web sites in their information problem solving, 10% preferred to use books and journals, and 30 % did not have a preference for either. Both the study by Wolf and colleagues and the Herring study indicate that students could benefit from scaffolded instruction as it seemed to help

students develop metacognition about the search for and use of information in different tasks.

Summary. Research on K-12 students' Web search behaviors and strategies shows that children may be enthusiastic about Web searches, but also often have difficulties in locating relevant information. Students do not always explore the Web with a plan but rather stay focused on finding one answer to their question, even when tasks ask for their opinions. Search results seem to be taken as the end point rather than the beginning of a process of making sense of information gathered. It seems that students tend to use the same strategies whether they are engaged in fact-based tasks or research-oriented tasks.

Prior knowledge is an important factor to consider when students search for information. Prior knowledge of the domain may be relevant in both formulating appropriate key words and the selection of relevant information. Several studies suggested that students would benefit from scaffolded instructional activities to support more effective Web searches and information management to solve different types of tasks. Both types of skills require training and support. While older students were shown to be more successful in their searches in some studies, curriculum and instruction may also have an impact on the development of information problem solving skills.

The Web, as a tool for information searching and learning, seems to motivate students, offers current content and primary sources, and provides a framework for fact-finding and open-ended tasks. As an environment for learning, the Web may be both exciting and frustrating. Overall, a number of studies show that most students like using the Web despite the problems they may encounter. Benefits of learning with the Web are

less clear as most studies focus on behaviors related to searches for information rather than learning outcomes.

The findings do not seem to be uniform across studies (e.g., the influence of the type of a task on the search for information). The review nonetheless reveals a fairly rapidly growing body of knowledge about K-12 students and their interaction with the Web. The majority of studies are descriptive in nature. Examining processes calls for an interpretive framework, imposing some limitations on generalizations because of the contextualized nature of the research.

K-12 Students with LD and the World Wide Web

Gardner, Wissick, and Schweder (2003) suggest that "one of the most recent and significant changes to the way we use technology to support instruction for students with disabilities in classrooms may exist in the use of the World Wide Web" (p. 161). The Web offers a number of sites and materials that can contribute to students' active engagement in learning about social studies (see Okolo, 2005, for a number of Web sites with digital documents, archives, and projects related to social studies). The Library of Congress, historical museums, state and national parks, and some universities, offer both primary and secondary sources (Okolo, 2005).

Within the Library of Congress (www.loc.gov), there are a number of lesson plans and thinking sheets available for teachers and students to use with different units. Also, digital archival information is available. For instance, instead of reading about slavery only in their textbooks, students may read digitized oral accounts of former slaves. Via hyperlinks, students may occasionally listen to audio files of these stories that allow them to experience history. Web sites, such as iEARN and KidLink, provide

opportunities for student collaboration throughout the world. Civics and government Web sites offer standards and online curriculum materials (http://www.civiced.org) for teachers. Because students with reading disabilities are often taught social studies and science in general education classrooms (e.g., Ferretti, MacArthur, & Okolo, 2001; Okolo, Ferretti, & MacArthur, 2007), it is important to examine how the Web can be used to support the learning of these individuals.

In science education instruction, Kimmel, Deek, and Frazer (2002) suggest that there is a need for a shift in science instruction to include more dynamic and multisensory methods that engage and motivate learners. While some students may learn better with print, some may benefit from additional images and/or sounds (Mayer & Moreno, 2003). Accommodating different students' needs is essential when considering students with LD and may be provided through the Web. There are virtual laboratories and simulations (e.g., www.biologylab.awlonline.com), virtual dissections (e.g., www.froguts.com), and science Web-based environments (e.g. WISE – http://wise.berkeley.edu/) that may facilitate teaching and learning.

Some studies that integrate information processing skills with science content knowledge acquisition reveal mixed results (e.g., Todd, 1995). Todd (1995) tested the assumption that information processing skills instruction, integrated into the science curriculum for ninth graders, contributes to student achievement in a specific subject area as well as to overall student attitudes and motivation. The sample was drawn from Marist Sister's College, a non-government, mixed-ability, multicultural high school in Sydney that enrolled 750 girls. The school's library media specialist and the science teacher, with expertise in teaching information processing skills, taught and planned units together.

Todd employed a posttest-only comparison group design to measure the effect of the "method of instruction" variable on two groups of randomly assigned students: two science classes of 20 students in each of the treatment groups and two classes of 20 each in the control groups. The program was built around the six stages of the information processing process: (1) defining, (2) locating, (3) selecting, (4) organizing, (5) presenting, and (6) assessing information.

The two classes in the control group followed the state-prescribed curriculum without integration of information skills instruction and their teachers taught without collaboration with the school library media specialist. Students' mastery of science content and skills was measured by the mid-year and end-of-year science exams. Tests were devised collectively by the science teachers. As the researcher failed to identify any suitable test for assessing students' information skills, a simple skills test was developed by the research team. Students were presented with scenarios and had 30 minutes to write their responses. Based on content analysis, students scored a point for each instance that evidenced an application of one of the six stages of information processing. Both groups were pretested to establish their academic ability, information processing skills, and knowledge of science content. The students' general reasoning ability was also assessed and attitude measures were administered after each instructional period.

The classes did not show significantly different means for academic ability scores at the outset of the teaching program. However, both treatment classes showed higher annual science scores than the control group after the treatment. The "method of instruction" variable yielded a significant impact on students' mastery of science content. Todd (1995) concluded that an integrated information skills approach to teaching and

learning had a positive impact on learning outcomes. The treatment classes also showed a significant improvement in information processing skills on the experimental measure. Todd concluded that these findings raise the issue of equity in education as it might be argued that students not provided instruction in integrated information processing skills are not being given adequate educational opportunities.

In terms of motivation for schooling, performance-based academic self-concept, and instructional mastery, there were no significant differences between the groups overall. The trends identified showed that, in terms of reference-based academic self-concept, in which students assessed how others viewed their school performance, the control group scored higher than the treatment group. The treatment group also scored less favorably in terms of their perceptions of their control over their learning and development toward independent learning. This finding seems to contradict the picture of students who enjoy working with the Internet (e.g., Pritchard & Cartwright, 2004). It also contradicts viewing the engagement in search for information and the Web learning environment as allowing for greater independence in learning (as opposed to a teacher lecture or a textbook).

However, the findings also revealed that the effect of information problem solving instruction did not remain constant across the levels of ability. Students considered below average did not appear to make any improvement in their science content knowledge assignment scores in the treatment condition. These findings were not consistent with Todd's previous qualitative study of students with disabilities in the same school who made a considerable improvement in their final science scores after a year of information problem solving instruction integrated into their science curriculum. The author attributed

this difference to the fact that students with LD in the earlier study were not in a mixed-ability class and received instruction in information problem solving skills through strategies tailored specifically to their learning problems.

Students with LD may lack sufficient skills to learn and benefit from the material provided on the Web. The exploratory study briefly mentioned before using informational Web-based texts with six upper elementary students (three general education students and three students with a LD in reading), showed great individual variation in approaches to locating and extracting information from hypertext (Curcic, 2005). The students were selected as participants based on reports that they used computers at home. All students used computers for Web searches at school. The primary source of data was gathered through the observation of focal students on the task of search for information to be used in writing a report on an animal (specifically, a kangaroo). The Web sites uploaded on the school's Web page varied in their readability, navigability, overall design, and the number of hyperlinks included.

During their searches for information, general education students opened five Web pages, while students with LD in reading opened one Web page only. In addition, the general education students seemed to employ strategies that were more beneficial. For example, they showed more attention to the text structure in both extracting information and organizing their information for their reports. General education students copied sentences, printed them out, and read over them. Then, they organized their texts into paragraphs, adding their own comments. Students with LD in reading relied on copying and pasting information from the screen, without an attempt to organize their texts or

insert their own comments. All six students varied greatly in the amount of information they included in their writing (ranging from one to 13 paragraphs).

The three general education students exhibited shifts in main ideas in every paragraph, as opposed to a list-like writing by some students with LD. Studies with traditional texts reveal that text structures are considered important organizational schemes underlying effective comprehension (Butcher & Kintsch, 2003; Englert & Hiebert, 1984; Englert & Thomas, 1987; Meyer, 2003; Spivey, 1997; van den Broek, 1994). It also has been reported that students with LD seem to lack sensitivity to text structures (e.g., Englert & Hiebert, 1984; Williams, 2003). The complex hypertext environment, where text structures may shift abruptly, may create further gaps between students with LD and general education students in tasks that require attention to the selection and organization of information.

In spite of the availability of specific Web-based assignments, Gardner et al. (2003) noted that for students "who are traditionally challenged in the areas of reading, finding information on the Web can be both frustrating and overwhelming" and suggest as one solution the "use of student-friendly search engines and online encyclopedias", such as: AskJeeves for Kids http://www.ajkids.com, Yahooligans (http://www.yahooligans.com), L1kids (http://dknet.lineone.net/encyclopedia), and Fact Monster (http://www.factmonster.com/encyclopedia.html) (p. 163). These authors also recommend Web-Quests as a way of scaffolding instruction (http://edweb.sdsu.edu/ webquest/webquest.html). Web-Quests are Web-based environments with inquiry projects in which students follow a sequence of steps. Gardner and Wissick (2005) provide the description of elements and a number of URLs containing WebQuests (pp.

700-701). Some authors suggest that using the Web may offer an engaging environment for learning. For example, students can participate in "inquiry-oriented activities" by being directed to specific Web sites to complete assignments (Gardner & Wissick, 2005, p. 698). Gardner and Wissick (2003) also suggest using online tools that may assist teachers in designing inquiry and problem-based activities such as http://www.ed.sc.edu/caw/toolboxcreateyourown.html.

Studies with students in upper elementary grades with traditional texts show that it is possible to improve students' information literacy within the context of inquiry projects (Dreher, Davis, Waynant, & Clewell, 1997). Dreher and colleagues conducted research with fourth graders in two schools (13 in one school and 26 in the other) over one year. The instruction was conducted within the context of social studies. Teachers taught children the components of the research process, which proceeded from asking questions to gathering information, organizing that information, and creating and revising drafts of reports using the information. The process was presented as recursive rather than linear. At both schools, students showed significant improvements in their search for information, writing a response to research questions, and applying what they learned, although one school had a larger number of poor readers than the other. The findings are somewhat limited as there was no control group assigned.

Based on their findings, Dreher and colleagues stress that although research skills instruction seems to be important for all students, it may be particularly important for students with lower reading skills because these students may be less exposed to research projects and not asked to write expository texts as often. Therefore, it seems that

particular attention should be dedicated to students with LD in reading, with a focus on instruction that would support their information processing and research skills.

In spite of the optimism surrounding technology use in classrooms, Boone and Higgins (2005) warn that we should be aware of the distinction between access to technology and access to learning. They suggest that adopting technology is both easy and probably inevitable. However, they also note that research on the assessment of using technology has not focused enough on its application in educational contexts.

Summary. The Web constitutes an educational environment that may be more engaging than textbooks. For example, museum tours, history brought to life, the possibility of examining primary sources, and the availability of simulated scientific experiments may offer an interactive and engaging environment. There are a number of Web sites that may allow teachers to scaffold and differentiate their instruction (e.g., Web-Quests). The review of studies of students with LD and Web engagement reveals that research is very limited in this area. There are more suggestions of what teachers could do with the Web than studies of how teachers and students use the Web and the impact of that use. It seems that an urgent task before educators is to examine the ways in which we can support struggling students' online learning.

The K-12 education curriculum includes a number of literacy skills, including information processing skills and research skills. Exploratory studies seem to indicate that students with LD in reading could use instruction and support in developing these skills or otherwise face further barriers in their education. Studies with students in upper elementary school, including poor readers, show that it is possible to improve students'

informational processing skills and that text search instruction may be particularly important for students with lower reading skills.

Information Problem Solving and The Big6 Skills Model

Symons et al. (2001) note that students first encounter reading-to-do tasks, such as information search, during the elementary years. Yet, we know little about the developmental progression of students' information problem solving skills. Symons and colleagues (2001) also suggest that the problem solving tasks may be "particularly amenable to instructional efforts" (p. 3). Based on the literature review, it was hypothesized that the Big6 Skills might support students with LD in becoming strategic in their information problem solving and "reading-to-do tasks". Reading-to-do tasks and information problem solving have been examined under the topics of "writing-from-sources" or "discourse synthesis" (e.g., Nash, Schumacher, & Carlson, 1993; Spivey & King, 1989). For example, Nash, Schumacher, and Carlson (1993) identify several activities involved in such tasks. The writer is expected to: (1) choose a topic; (2) locate and evaluate information; (3) select information from the sources; and (4) organize and compose the essay. The steps are not necessarily followed in a linear fashion. Most of these steps are incorporated into the model used in this study, the Big6 Skills, discussed next. Several findings from "writing-from-sources" studies are discussed later in this section.

The Big6 Skills model. There are various models of information problem solving and the Big6 Skills is just one of them (e.g., Guthrie, 1988; Kuhlthau, 1997; Herring, 2006). The primary reason why this model has been chosen for this study is the fact that it seems to incorporate important steps in information search (e.g., task definition,

information seeking strategies, location and access, use of information, synthesis, and evaluation). The last step, evaluation, aims at developing metacognition, also an important aspect of learning, especially for students with LD.

The Big6 Skills has been described as an approach to help students develop skills and understanding of information problem solving (Eisenberg & Berkowitz, 1999). It also is described as a process, which consists of six stages in the location and use of information, although the process is not necessarily linear. Teaching students to break down the components of complex tasks is instruction in strategic learning. Strategies are processes matched to the requirements of tasks and learners, aimed at facilitating performance (Pressley, Goodchild, Fleet, Zajchowski, & Evans, 1989, p. 303). Strategies as processes are introduced within contexts. There are two main contexts for successful Big6 Skills instruction: (1) real needs–either curricular or personal, and (2) the process itself with two questions to consider in the process: "What's the curriculum or personal need" and "Where am I in the Big6 process?" (Eisenberg & Berkowitz, 1999, p. 33).

In their discussion of online information problem solving, Eisenberg and Berkowitz (1999) suggest that we do not start instruction with the Web but rather with the problem. Next, the students learn to identify sources given the situation presented on the Web. To determine the best sources, the students engage in viewing/reading information and explain their choices. The students learn to apply criteria (e.g., information selected is associated with and will help address the problem). The students also learn to organize and synthesize their information. Finally, the students reflect on their product (e.g., research report or essay) and processes involved in creating the written product.

After an introduction to the task, instruction in the Big6 Skills in the present study begins with explanation and modeling (e.g., Pressley et al., 2006). The students are oriented to the text structure of hypertext. To support the information processing skills of seventh and eighth grade students with LD in reading, the treatment group was instructed in the Big6 Skills and provided with two graphics: a chart listing the Big6 Skills and an essay map organizer. The control group was instructed to use the essay map organizer also.

The new literacies framework (e.g., Coiro et al., 2008) proposes additional skills to be developed, such as critical evaluation of the sources on the Web. In many schools, the Web pages are loaded on the schools' Web sites and students are not necessarily instructed to question these sources. At the same time, many schools do engage in instructing the students how to evaluate various Web sites. Because of the complexity involved in teaching students information problem solving as opposed to evaluating the Web sites, students are often instructed separately in understanding these two processes.

Writing from multiple sources. In this study, the students engaged in information problem solving for the purposes of writing reports for a Social Studies and Science Fair. The students' traditional searches for information related to academic writing had been conducted predominantly within specific textbooks, books, and magazines. Online reading and learning underscore the need for developing competencies that combine reading and writing as connected. As Gambrell and Koskinen (2002) note, writing "is the process of selecting, combining, arranging, and developing ideas, and it [composition] is therefore a reflection of comprehension" (p. 307).

As children progress in their schooling toward the upper grades, they are increasingly expected to read, write, and comprehend various expository texts such as material about science, social studies, geography, and other disciplines (Wilson & Rupley, 1997). Also, as children progress from grade to grade, written language demands advance from informal to more formal writing (Calfee & Wilson, 2004). Many students find it challenging to create formal texts. In particular, the knowledge of students with LD about writing (e.g., genre, devices, mechanics) tends to be limited (Graham & Harris, 2003).

Writing based on multiple sources might complicate the process of composing even further. For example, Raphael and Boyd (1991) reported on two studies with late elementary students with a particular focus on the way these students synthesized information from multiple sources of nonfiction articles. Using a naturalistic design, they observed various inhibiting strategies employed by the children, who: (1) used associative memory or recall (ideas are linked to one another but without an overarching organization); (2) showed insensitivity to audience; (3) digressed from the topics because they overemphasized a reliance on background knowledge; (4) copied verbatim (strategically or randomly); (5) narrowly identified relevant information; and, (6) engaged in writing a story as opposed to an expository text. The students' own purpose for writing did not necessarily match those of the teachers. The authors concluded from follow-up interviews that children were not necessarily lacking strategies, but brought their own impressions to the task and thus corrupted the assignment. For example, some students thought that when people write reports they do so to express what interests them personally rather than what would interest other people. Also, some students appeared to

assume that their audience is the adult who gave the assignment and therefore provided very little context for a reader. It seems clear from these studies that students should write for an audience other than their teacher.

Kirkpatrick and Klein (2009) noted that writing from sources is an important determinant for school success, yet an under-researched topic. They suggest that one of the most important aspects of any written text is its structure. In a pretest-posttest quasi-experimental control group design, they instructed 83 seventh and eighth graders to write from sources, with a particular focus on planning and compare-contrast text structure. Both the control and experimental group had a few students with disabilities. The instructional unit consisted of six lessons, lasting approximately six hours. The writing instruction unit had a greater impact on students with low writing ability than on the students with high writing ability. This occurred in both conditions and there was no interaction between condition and students' writing ability on gain scores. However, an ANOVA showed a main effect of condition for holistic grade—the students in the writing condition had greater holistic grade gain scores than the students in the control condition. The authors concluded that given the poor performance at pretest and large gains at posttest in compare-contrast writing, the instruction in genre-appropriate text structure might be especially important. They also noted the difficulty of the task of writing from sources. Students must decontextualize information from the goal of the original author(s) and recontextualize information to meet their own goals as writers.

Spivey and King (1989) reported that reading ability was related to students' writing from multiple sources. Proficient readers in their study included more content in their writing reports, were better at synthesizing information, and also were better at

organizing their texts. Spivey and King repeated research conducted with college students with sixth-, eighth-, and tenth-grade students. They showed that older students included significantly more content in their reports than younger students. However, a planned ANOVA that compared the students by grade and reading ability found a main effect for reading ability, but not for grade. The authors concluded that the ability of the students to organize the content for their writing was an important link between reading ability and writing ability. In studies in which the students were not encouraged to present their own ideas, the participants tended to rely more on information from the sources in writing their reports. They also noted that when tasks are ill defined, greater variability in processes and products is to be expected. Spivey and King, therefore, argue that research into literacy must not attend only to cognitive factors, but also to task factors.

Metacognition and strategy instruction. Metacognition has received a great deal of research attention, but less research is related to the metacognition of children's information problem solving. Palincsar (1986) defines metacognition as the ability to plan, implement, and evaluate strategic approaches to learning. Brown (1987) suggests that a positive outcome of researchers' interest in metacognition is attempts to understand development in learning situations through interactive intervention studies: as the child adopts more of the skills initially undertaken by the adult and gradually learns how to learn, the adult relinquishes control. Wood, Wood, and Middleton (1978) and Stone (1998) refer to this form of adult assistance as scaffolding. Wood and colleagues emphasize that the end product is not the only goal. They stress that it is also important that a child becomes cognizant of what was involved in the successful completion of the task.

Metacognition is critical to effective strategy use. Cognitively oriented research on writing has underscored the active role of the writer who engages in the complex recursive and iterative processes of writing, such as planning, drafting, and revising. The complexity of the writing process, as well as its metacognitive dimensions, has led to research on writing self-regulation and strategy instruction (e.g., Englert, Raphael, Anderson, Anthony, & Stevens, 1991; Graham & Harris, 1989; Pressley, Schuder, Bergman, & El-Dinary, 1992; Troia & Graham, 2002). Without adequate metacognitive awareness and self-monitoring strategies, students with LD experience serious deficits in written language (Englert et al., 1991; Wong, 2000). Instructional design and individualized support therefore need to take into account the literacy challenges of students with LD.

A long line of research with students with LD reveals that these students benefit from strategic approaches to literacy and development of metacognitive knowledge and actions (e.g., Englert, Raphael, Anderson, Anthony, & Stevens, 1991; Englert & Mariage; 1991; Gersten, Fuchs, Williams, & Baker, 2001; Graham, Harris, & Troia, 2000; Pressley, Johnson, Symons, McGoldrick, & Kurita, 1989; Troia & Graham, 2002). For example, Graham and his colleagues conducted a number of investigations intended to use strategies to improve students' writing, especially students with LD. The teacher models and discusses strategies with the students. The instruction leads to self-regulated writing, in which students are taught to monitor and evaluate their performance. Englert and her colleagues (e.g. Englert et al., 1991) also employed strategy instruction to improve writing of students with LD. Students were asked to follow a set of questions that cue the students toward the purpose and the audience in planning for their writing.

One of the expected outcomes of the study reported here was that students would adopt a strategic and metacognitive approach to the search, location, selection, and organization of information through instruction in the Big6 Skills approach to information problem solving, and that this change in their approach would be reflected in their written products.

Scaffolding. In their work on parent-child interactions, Wood, Bruner and Ross (1976) introduced the scaffolding metaphor. They noted that "...scaffolding consists essentially of the adult 'controlling' those elements of the task that are initially beyond the learner's capacity, thus permitting him to concentrate upon and completing only those elements that are within his range of competence" (p. 90). The types of assistance that an adult might provide could be: (1) recruitment (engaging student interest); (2) reduction of degrees of freedom (constraining the task); (3) direction maintenance (supporting goal-directedness and risk-taking); (4) marking critical features (highlighting discrepancies between progress and goal); (5) frustration control (mediating frustration and independence); and, (6) demonstration (modeling solutions) (Wood et al., 1976, p. 98).

Stone (1998) describes several critical features of scaffolding. First, a child is recruited by an adult to be involved in a meaningful and desirable activity beyond the child's current understanding or control. Second, the adult monitors the child's skill level or understanding and adjusts the support. The supports might vary from nonverbal assistance (modeling or pointing) to extensive dialogues. Finally, the support provided by the adult is gradually withdrawn and the child assumes the responsibility for the task completion.

Scaffolding through extensive dialogues has been employed in reciprocal teaching work (Palincsar & Brown, 1984). In reciprocal teaching, the students and adults take turns in the role of a teacher and in leading the group toward understanding a selected paragraph of the text. The teacher for a certain paragraph asks a question about it, summarizes it, asks for clarifications, etc. Likewise, a collaborative and dialogic scaffolded approach is used in the instruction of students taught the POSSE (Predict, Organize, Search, Summarize, and Evaluate) strategy (Englert, Tarrant, Mariage, & Oxer, 1994). Students are taught through graduated questioning and procedural facilitation through the use of cue cards with specific strategies. These instructional studies based on the scaffolding metaphor obtained large effects.

Motivation. Another important consideration in instruction, especially for students with LD, is related to motivation. Troia, Shankland, and Wolbers (in press) state that self-efficacy beliefs, goal orientation, interest in task, and attributions for success and failure, all contribute to motivation. In this view, motivation is not simply present or absent but rather is a multidimensional component in academic domains. In the domain of writing, Troia et al. (in press) point out that, in spite of the fact that writing may be a valued social practice, its "relevance, importance, and benefits" may not be obvious to students (p. 20). It seems that although an important dimension in all human activities, motivation remains under-researched in academic tasks assigned to students in K-12 schooling contexts.

In the domain of reading, interest and positive affect toward reading have been associated with higher cognitive effort and comprehension of texts (Guthrie, Hoa, Wigfield, Tonks, Hymenick, & Littles, 2007). Guthrie and colleagues found that students

in later elementary grades did not have a well-developed sense of general efficacy but had a strong sense of situational efficacy (e.g., linked to a particular book rather than a general sense of being a good reader). In addition to self-efficacy, there were associations among interest, perceived control, involvement, and collaboration. The students' interest was correlated with their cognitive engagement, based on analysis of coded self-reports. The students highly valued when they could choose their own books to read (perceived control) and had a positive affect for collaboration.

Hidi and Harackiewicz (2000) stress the importance of distinguishing between individual interest and situational interest. They suggest that individual interest may help students sustain their attention for a topic in spite of a boring presentation, while situational interest may enhance student motivation because of the way particular texts are presented. In this study, students will be presented with a Likert motivational scale related to a specific topic before they are presented with the Web-based learning task. It is assumed that the scale will measure individual interest rather than situational interest, although it also seems that in practice these two concepts (individual and situational interest) are not necessarily easy to separate.

CHAPTER 3

METHOD

The purpose of this chapter is to describe the methods and procedures of the study. First, the characteristics of the participants and the setting are described. Second, the experimental procedures and assignment of participants to conditions are described, and finally, the administration of the intervention is described.

An experimental pretest-posttest control group design was used to examine the effects of intervention in text search and information management. Specifically, this design involved two groups of seventh and eighth grade students with reading difficulties who were matched on several variables that were controlled (i.e., verbal and perceptual abilities, Internet skills, reading comprehension) and randomly assigned to the treatment and control groups. This design is a variant of a repeated measure design, also termed a "matched sample design" (Howell, 2002). In addition, qualitative data were gathered through a semi-structured interview to examine students metacognition related to the intervention.

Participants

Twenty students with LD and learning difficulties in grades seven and eight in a Midwestern K-12 non-public school participated in this study. Both the treatment (n=10) and control group (n=10) had an equal number of seventh (n=5) and eighth graders (n=5) in each group. The students were included if they met the following stepwise criteria:

(1) the student is identified by the school as a student with LD;

(2) the student has a normal verbal IQ (85 or greater);

(3) the student has no sensory or motor deficits or social/emotional disorder; and

(4) English is the student's first language.

Upon obtaining IRB approval, letters were sent home to 37 seventh and eighth graders through the school mail. Twenty-five parents responded positively (68% response rate). Once the consent letters were obtained, I followed up with recruiting participants individually and those who agreed to participate signed an assent form. For the purposes of the final analyses, not all of these students were included for the following reasons: (a) one student was diagnosed with emotional-behavioral disorder (EBD) and did not meet the stepwise criteria; (b) one student had a below average verbal IQ score and also did not meet the other inclusion criteria; (c) one student participated only sporadically because, as he explained, he "hated reading, writing, and computers"; (d) one student had autism, and (e) one had Asperger's syndrome. Three students who had below 85 IQ (in the range of 73 to 77) were included in the study. Two of these students were in the treatment group.

The demographic characteristics of the participants are displayed in Table 1. Table 1 also includes the scores for the key measures used to match students before random assignment to condition. These include: (a) an averaged standard score for verbal IQ (VIQ) and verbal comprehension index (VCI) from the Wechsler Intelligence Scale for Children-IV (WISC-IV); (b) an averaged standard score for perceptual IQ (PIQ) and perceptual reasoning index (PRI) from the WISC-IV; (c) a standard score for reading comprehension from the Passage Comprehension (PC) subtest of the Woodcock-Johnson-III Tests of Achievement (WJ-III); and (d) a total raw score from a modified version of the Teaching Internet Comprehension Skills to Adolescents (TICA) checklist

TICA (Leu, Reinking, Carter, Castek, Coiro, Henry, et al., 2007). The TICA modified version was used because the specific Web sites to be researched were preselected.

Table 1. *Demographics and Matching Variable Performance of Student Participants*

Variable	Treatment		Control	
	n=10	Mean (SD)	n=10	Mean (SD)
Age				
13	5		5	
14	5		5	
Gender				
Male	6		4	
Female	4		6	
Ethnicity				
African American			1	
Asian	1			
Caucasian	8		8	
Hispanic	1		1	
VIQ/VCI Average	91.50	(11.47)	97.10	(14.36)
PIQ/PRI Average	92.30	(15.60)	101.40	(21.78)
Passage Comprehension	82.90	(6.05)	85.10	(8.71)
TICA	19.30	(1.25)	19.80	(0.42)

Setting

The selected school for this study was a K-12 non-public Midwestern school. This school was selected because it enrolls students with LD. Recently, the school had expanded enrollment to include students with emotional disorders and other impairments (e.g., autism). The students came from 50 school districts throughout the greater metropolitan area and varied from low (approximately one third of the student population) to high SES (also approximately one-third of the students with some of them directly enrolled by their parents, without going through school district referrals).

The research was conducted in the computer lab of the school. The computer lab had about 20 Macintosh desktop computers. I conducted sessions predominantly with individual students, although four small group sessions were also scheduled during the midpoint of the project with both the treatment and control students. In the computer lab, there were occasional sessions during which other children not involved with the study worked individually with speech-language pathologists.

All students shared the same computer lab teacher and the same library teacher. The students were instructed in cohorts so that seventh and eighth graders attended the classes together. The teachers followed the same curriculum, which was highly scripted (according to the teachers and, also, according to observations), especially for language arts and math.

Data Collection and Analyses

Data collection. Multiple sources of data were collected. First, during December 2008 through mid-March 2009, I observed once a week for two to three hours in language arts, social studies, science, library, and computer lab classes. Observations

were recorded in the form of field notes. Second, I collected data relevant to the matching variables based on norm-referenced tests from students' files. Third, I administered surveys and questionnaires (TICA checklist, prior knowledge questionnaires, and motivation scales). Fourth, I recorded the number of links that the students opened during their Web searches for their research papers. Also, students' writing artifacts were collected for further analyses. Lastly, the treatment students responded to a semi-structured questionnaire at two points during this study to share the perceived benefits of working with the Big6 Skills steps.

Data analyses. To answer the research questions, the quantitative analyses took into account offline reading ability and intelligence (Passage Comprehension subtest scores and averaged scores for VIQ/VCI and PIQ/PRI, respectively) and online performance (the TICA checklist). Further analysis took into account prior knowledge and topic-specific motivation. Product measures (scores on a writing quality rubric and text length) and the navigation measure (number of hyperlinks accessed) were also taken into account during analyses. The rationale for these measures was as follows:
(a) *Prior topic knowledge* (pre-intervention, intervention, and post-intervention phase). The prior topic knowledge was measured before each topic was introduced using a brief questionnaire consisting of five true-false items. Research shows that prior domain knowledge may influence online reading comprehension although the findings also show some mixed results (Coiro, 2007; Tolhurst & Debus, 2002). The measure was scored as correct versus incorrect, with the maximum score of 5. The questionnaire can be found in Appendix K.

(b) *Motivation* (pre-intervention, intervention, post-intervention): A Likert-type motivational scale (see Appendix H) was administered before students engaged in search for information and therefore is assumed to reflect the student's interest in the topic rather than the potential of texts to contribute to motivation. Motivation is related to students' engagement in a task and therefore an important consideration in instruction (Troia et al., in press).

(c) *Product measures* (pre-intervention, post-intervention). The quality of the products (expository texts for the Fair posters) written during pre- and post-intervention sessions was measured using the RAFT writing rubric (Figure 2), which evaluates writing quality using a 4-point scale on four dimensions: topic, organization, sentence structure, and mechanics of language. This rubric was used to assign a summative score across traits, with the total possible points of 16. Text length was measured by word count.

(d) *Text length* (pre-intervention, post-intervention). The length of the written products was measured by word count.

(e) *Navigation* (pre-intervention, post-intervention). The number of links opened was counted for most topics researched on the Web. The literature review reveals that navigation, including the number of links opened, influences successful access to and use of information on the Web (e.g., Salmerón, et al., 2005).

(f) *Semi-structured questionnaire.* The purpose of the semi-structured questionnaire was to gather data on the students' perceptions of usefulness of the Big6 Skills approach to information problem solving. The interviews were asked at midpoint and at the end of the study. Some students were able to consider their actions and describe them, revealing their metacognitive awareness of their learning, although the descriptions were somewhat

imperfect (Brown, 1987). Some reports were also somewhat limited (i.e., without much elaboration).

Figure 2: RAFT Rubric

Category	4	3	2	1
Topic	There is one clear, well-focused topic. Main idea stands out and is supported by detailed information.	Main idea is clear but the supporting information is general.	Main idea is somewhat clear but there is a need for more supporting information.	The main idea is not clear. There is a seemingly random collection of information.
Organization	Details are placed in logical order and the way they are presented effectively keeps the interest of the reader.	Details are placed in logical order, but the way in which they are presented/introduced sometimes makes the writing less interesting.	Some details are not in a logical or expected order and that distracts the reader.	Many details are not in logical or expected order. There is little sense that the writing is organized.
Sentence length and variety	All sentences are well-constructed with varied structure.	Most sentences are well-constructed with varied structure.	Most sentences are well-constructed but have a similar structure.	Sentences lack variety and appear incomplete.
CUPS	Writer makes no errors in grammar, spelling, capitalization or punctuation that distract the reader from the content.	Writer makes 1-2 errors in grammar, spelling, capitalization or punctuation that distract the reader from the content.	Writer makes 3-4 errors in grammar, spelling, capitalization or punctuation that distract the reader from the content.	Writer makes than 4 errors in grammar, spelling, capitalization or punctuation that distract the readers from the content.

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Pilot study. Preliminary data were collected through informal observations of one student. The Big6 Skills has two versions for younger readers. The pilot was useful in making a decision to implement the simpler version of the Big6 Skills handout– summarized on one page, rather than two. The student's task in the pilot study was to write a report about electricity and conductors rather than make a poster. The steps of the Big6 Skills were taught holistically. The student work clearly showed progress over four sessions from writing two sentences to writing two paragraphs and moving away from relying strictly on copying and pasting.

The pilot study indicated that close attention should be paid to the following factors: (a) the task should be well determined so that students stay focused on a particular topic or inquiry; (b) students must understand the function of the links on the screen; (c) the teacher should help students connect previous knowledge with information presented on the screen; (d) students must understand the vocabulary used in the Big6 Skills and also on the Web sites; and (e) students should use a spell checker and dictionary/thesaurus. Lesson plans reflect these points (Appendices E and F).

General Procedures

Assignment to conditions. In this study, treatment refers to the intervention through instruction in the Big6 Skills information problem solving model. A visual organizer in the form of an essay map was also utilized. The control group engaged in the same tasks, without instruction in the Big6 Skills. The control group was instructed in using the same essay map visual organizer.

All students were assessed using the WISC-IV and the WJ-III test by the school psychologist. The WISC-IV is an individually administered clinical instrument for

assessing the cognitive ability of children aged 6 years though 16 years and 11 months. For the purposes of this study, two averaged scores were used from WISC-IV as the basis for matching the students prior to assignment to conditions: VIQ and VCI averaged scores and PIQ and PRI averaged scores. VIQ is based on the Information, Similarities, Arithmetic, Vocabulary, and Comprehension subtests. VCI requires verbal conceptualization, stored knowledge access, and oral expression and is based on Similarities, Vocabulary, Comprehension, Information, and Word Reasoning subtests. PIQ is based on the Picture Completion, Coding, Picture Arrangement, and Block Design subtests. PRI requires visual perception, organization, and reasoning with visually presented nonverbal material to solve problems that are not typically used in schools and is based on the Block Design, Picture Concepts, Matrix Reasoning, and Picture Completion subtests. Thus, the average of these derived scores represents the most complete and comprehensive estimation of the students' overall intellectual functioning.

The WJ-III is a test designed to measure academic achievement in most school subjects. The score on the Passage Comprehension subtest of the WJ-III test was used as one of the matching variables. Students are asked to complete missing information in sentences and passages. The examination of student participants' files revealed students had LD in reading, but also that two students might have had additional difficulties due to ADHD and three students had a score lower than 85 in VIQ or PIQ. The students also were matched on the scores from a checklist for the evaluation of Internet skills based on a slightly modified version of the TICA, developed by Leu, Reinking, Carter, Castek, Coiro, and Henry et al. (2007) and presented in Appendix B. The complete instrument includes e-mail basic skills, which were not central to this project, and skills involved in

using keywords and search engines, which were not included on the modified version because the students used predetermined and loaded Web sites. Before the intervention, I observed that all students knew how to use search engines (predominantly Google) and how to perform searches. The final assignment to conditions was completed after the pre-intervention during which I assessed students' Internet skills, using the TICA checklist (Appendix B).

Context for information search. In collaboration with teachers, the context for information search was established as a task of creating Science and Social Studies Fair posters. Teachers identified a poster as a form that would be most suitable as a framework for science and social studies inquires. It also was decided that a poster allows more room for expression than writing strictly expository text, which might be more constraining for students with LD in reading who also often exhibit difficulties in writing.

The purpose of students' creating the poster was to inform the fourth graders at the school about social studies and science content they would be learning in subsequent grades. The reasoning behind this task was two-fold: (a) first, students were provided with an authentic audience for their Web inquires (Purcell-Gates, Duke, & Martineau, 2007); and, (b) students were asked to create a poster for younger students which required them to go beyond copying and pasting to express information in their own words so that younger children might understand the content (a point shared with the students during instruction in the task). The posters themselves were not used as data sources for this project, but simply provided the context for the writing students did.

Task instruction. All participants were instructed to access information through a Web portal and select information they deemed relevant to share with their younger

counterparts. I instructed students individually in the task delineated in Figure 3 (see Appendix A for the full version of the instructional procedures).

Figure 3: Basic task instruction.

> Task sample (pre-intervention):
>
> (a) Your task is to write a piece for the Science and Social Studies Fair to be shared with fourth graders here at your school.
> (b) Click on the page "Weather". Explore the links to find information about rain, thunderstorms, and lightening.
> (c) Open a Word document and take notes. Note some important ideas and some details. You may also include some images, if you wish.
> (d) Copy the URL (the Web address) where you found information for references at the end.

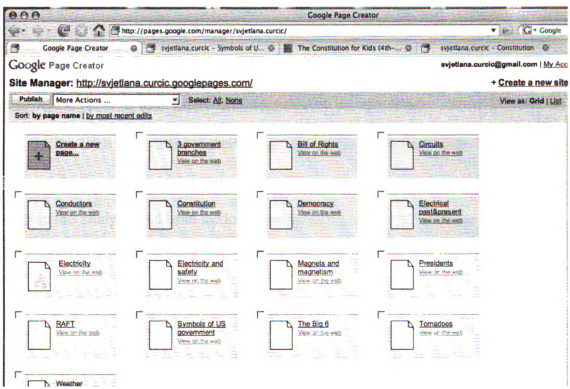
Reports for the posters were limited to one or two pages, although the pieces could be shorter. The length of writing was deliberately not strictly prescribed so that students were not preoccupied with the quantity of their work. The students' written pieces were saved and printed out for further analysis.

During my observations, I learned that the participants in the study were engaged in separate research projects that took place over several months. Students were assigned a task (e.g., choose one South American country of interest), conducted research in the library and record findings on a worksheet that helped structure their writing (e.g., geography of a country in South America, including location and surroundings, latitude/longitude, area, and capital, were to be recorded and used for a first paragraph under that topic in a report; major topographical features such as rivers, deserts, and mountains, and animals and vegetation found in the country, were to be recorded and used in the second paragraph under that topic; characteristics of the population, including

ethnic groups, religions, and languages, were to be recorded and used for a first paragraph under that topic for the report; and culture/major festivals and foods were to be recorded and used in the second paragraph under that topic). Then, the students would search for some Google images (e.g. the flag of a country) in the computer lab. Finally, the students would type up their reports in the computer lab based on their completed worksheets. At the end of the school year, the students had a presentation and a food feast celebration based on the selected countries. This study imposed a task of covering more topics in a shorter period of time, which made the task more challenging.

Web portal. For the purposes of information search, the Web portal (Figure 4) was created within a Google account. The selected Web pages were uploaded on the Page Creator. The topics relate to social science (e.g., three branches of the government, Constitution, etc.) and science (e.g., electricity, electrical safety, conductors, etc.).

Figure 4. Screenshot of the Web portal.



The topics were chosen based on consultation with teachers and examination of curricular materials provided by the teachers (e.g., the textbook for social studies and modules used for science). Each topic links to three Web sites on one page. When the screen opens, it displays a topic and the links to the Web sites (Figure 5). Clicking on a hyperlink leads to the associated Web pages.

Figure 5. Screenshot of *Electricity and safety* Web hyperlinks.

Opening the first link displays the text, images, and hyperlinks associated with the first topic in "Electricity and safety—Electricity can hurt and travel through you" (see the related Web site: Culverco.com, LLC at http://www.epcor.ca/elec_safety_world/hurt/travel_through.html)

The Web sites varied in their design, navigability and readability. Taking into account the averaged readability scores per Web page, the Flesch-Kincaid readability level in this study varied from the lowest score of 5.2 to the highest score of 10.9 (M= 8.19, SD=1.70).

Pre-intervention. During the first session, the task was the same for all students—to create a poster for the Social Studies and Science Fair for the fourth graders. Students were instructed to find information on the Web portal. The task was to identify

important information and write a report with at least three main ideas and three details for each main idea. The same script and protocol were followed for all students in pre-intervention (Appendix A: Lesson plan #1). During pre-intervention students explored one topic that was not a part of their current curriculum—the information search was on the topic of weather (rain, lightening and thunderstorms) and the topic of weather was also used in post-intervention (tornadoes).

As students worked on their task during the pre-intervention session, I evaluated their skills on the modified TICA Checklist. Most of the students could perform all the skills presented on the TICA. After the scores were obtained from the pre-intervention session, the students were matched and randomly assigned to the intervention or control group. The first pre-intervention topic was not a part of the curriculum but rather a topic that all students knew something about—weather. The "Weather" page had three links: "Rain", "Thunderstorms" and "Lightening". The posttest was also related to weather ("Tornadoes") because it became obvious that some students were learning about the U.S. Constitution, while some learned about WWII, and keeping the content the same at both time points ensured varied content coverage in the classroom would not become a confound. To account for the students' prior topic knowledge, I asked students before their Web searches five true-false questions. Also, a motivation scale was administered before each task (see Appendix H). The questions asked that students rate their interest in learning about the specific topic, researching about it, and writing a report for the fourth graders about it.

The same procedure was followed throughout all the sessions. First, I assessed prior knowledge orally, but also presented the true-false questions in print form on the

screen. Second, I administered a motivational scale orally but also provided a hard copy, read the questions, and recorded the students' answers. Third, we proceeded to research using the Web pages. Each session lasted approximately 40-50 minutes, the duration of one period, whether the students completed their task or not. If the task was not completed, their work was saved, and the students continued to work on their topic in the next session. The summary of all the topics and the Web sites for all the sessions is presented in Appendix I.

Intervention. During the second session, I instructed individually 10 treatment students in the Big6 Skills approach to information search and management through modeling and direct instruction (Appendix D; Appendices F and G: Lesson plans #2 and #3). Research indicates that students with reading difficulties benefit from explicit instruction (e.g., Duffy, Roehler, Sivan, Rackliffe, Book, Meloth et al., 1987). I modeled the search for main ideas and details with the Big6 Skills using the same topic as in pre-intervention and the same Web page and links. Modeling and guiding instruction followed the steps in the Big6 Skills captured in Figure 6.

Figure 6. Steps in the Big6 Skills

Basic Steps in the Big6 Skills
Step 1: Task definition.
Define a task: What needs to be done?
Step 2: Information seeking strategies: What resources can I use? (a) Skimming: Open the first link to the Web page. Scroll down the page to see what information is available. (b) Scanning: Scan the information available. (c) Open additional links. Scan the information available.
Step 3: Location and Access: Where can I find the resources? (a) Go back to the first link.

(b) Read the first sentence of the first paragraph.
(c) Consider the importance and relevance for the topic.
(d) Scan other paragraphs.
(e) Consider the text, but also images, if any.

Step 4: Use of Information: What can I use from these resources?
(a) Look at the essay map (Handout 2).
(b) Consider some main ideas and some details relevant to your topic.
(c) Take notes. Do you understand all the words; if not, break the words down, re-read, look at the context, check the dictionary under the Tools.
(d) Copy URLs (Web addresses) for your references and paste them at the bottom of your page.

Step 5: Synthesis: What can I make to finish the job?
(a) Consider whether you have an introduction to the topic.
(b) Consider whether you have at least three main ideas and three details that further explain these ideas.
(c) Add a conclusion to your piece.
(d) Read over your poster piece and seek the words that you don't understand or that you think would be too hard for second graders to understand. Rephrase sentences so that you retell the piece in you own words.
(e) Think about whether there is anything else you would like to add or learn.

Step 6: Evaluation: How will I know I did my job well?
How did you do in your search for information? Which strategies seemed to be useful? How did you do with writing the poster piece? How would you evaluate your poster piece?

Source: Based on The Big6 Skills Curriculum adopted from The "Big6™" - Copyright © (1987) Michael B. Eisenberg and Robert E. Berkowitz

In researching the second topic, "Three branches of the U.S. government", the treatment students were expected to look at Handout 1 (the Big6 Skills –Appendix C) and Handout 2 (essay map – Appendix E). I guided the students in the process as necessary. The students were reminded to (a) state the task, (b) use strategies to seek for information (e.g., open the links, skim and scan the information); (d) look for some main ideas and details; and (e) take notes in a Word document. Some students completed their task in one session and some students completed their task in two sessions. I monitored students'

performance with corrective feedback (Armbruster, Anderson, & Ostertag, 1987). More elaborated versions of the instruction in the Big6 Skills are in Appendices F and G.

The control group students were provided with the essay map handout and I instructed them on how to use the handout to facilitate their research and writing. The control group was asked to complete the same task without any instruction in the Big6 Skills steps. My involvement with the control group students was going to be limited to answering student questions, if any. However, the students asked a lot of questions because they were not sure how to approach the task and I, consequently, became very much involved in instructing the control group students as well. The students did not use the visual organizer independently and I had to prompt them to review whether they had an introduction, some mains ideas, and conclusion. One student regularly noted that "This is good for the fourth graders", implying that they do not need long reports.

The students in the treatment group who did not complete their task in the second session were asked to complete the task during the next session (mostly steps 5 and 6 of the Big6 Skills). Those students who did not complete their report in one period were instructed to look over their notes and consider ways to synthesize and organize them. The completion of the task and the time necessary to complete it sometimes varied depending on the school's schedule. For example, students would not hurry to the computer lab if they had previously played basketball.

When students had a tendency to copy and paste, I reminded them of the importance of stating the text in their own words and to remember that they were writing for fourth graders. This seemed to be a good approach and most of the students engaged in rereading and revising what they wrote.

Handout 2 (Appendix E: the essay map) served as a visual organizer to consider the text structure. The students were asked to review their report structure and to consider: (a) *Do you have an introduction to your piece? How will you inform your audience (fourth graders) what is your text going to be about*?; (b) *What are the main ideas?; Is there anything that needs to be explained into more details?;* (c) In the end, *do you have a summary statement/conclusion? Are there any important points that you would like your peers to remember?*; (d) *Do you think that younger students will understand all the words? Does anything need to be clarified*? One of the questions I originally anticipated that I would ask at the end was: *(e) Do you have the references at the end of your report?* However, it seemed that dealing with references would take much more time than anticipated and I decided not engage in instruction related to the references.

During the third session, those treatment students who completed their second topic in the second session, moved on to the topic of "Electricity". The control group was asked to complete the same task without any modeling of the search steps but was reminded to use the essay map. As noted, the students needed a lot of guidance in completing the task using the essay map. The idea of the "main idea" seemed to be particularly difficult to distinguish from details in informational texts.

The fourth topic to be explored was "Constitution". The treatment group was guided to look at Handout 1 (the Big6 Skills) and Handout 2 (the essay map). I first asked the question: *Do you remember what the task is? What needs to be done first?* Depending on the student answer, I encouraged the student to proceed or provided guidance as in the third session: (a) *consider the task*; (b) *strategies to seek for information* (e.g., open the

links, skim and scan the information); (c) *look for some main ideas and details*; (d) *take notes in a Word document; (e) follow the steps in the Big6 Skills.*

The control group was asked to complete their tasks individually, and initially, without any guided instruction. However, most of the students had questions such as: What shall I do? Where do I start?, etc. The students were not used to conducting research independently, whether in the library or in the computer lab, and I concluded that instruction is of paramount importance for these students as well, and guided them as necessary.

During the fifth session, the treatment group was expected to complete the task going through the steps of the Big6 Skills, guided as needed in the steps to be completed. The control group was to complete their task with guided instruction using the essay map alone. The topic was "Electrical safety". This was one of the most popular sites as noted in my field notes. Some of the reasons might be: (1) the first link at http://www.epcor.ca/elec_safety_world/hurt/travel_through.html had some general points about electrical safety. The second link at http://www.safeelectricity.org/esw_v1_1/safe_choice/index.html offered a game "Safe Choices" to play which had questions related to some everyday problems: a proper way to get toast out of your toaster, when/why to plug in or unplug things, playing music in a bathtub, and other questions about electrical hazards. The third link offered advice on how to avoid electric shock, which many students considered including in their reports because they thought it was important to inform the fourth graders about how to avoid a shock. While most of the students learned to open the three links provided originally, some students explored up to 16 links and hyperlinks within the site. The site seemed

appealing to both treatment and control students. During the sixth session, the students were presented with another topic from social studies, "Presidents", with the treatment group being guided as needed, and the control group performing the task independently, with minimal prompts.

During the seventh through twelfth sessions, guided instruction continued with fading prompts. The control group performed the tasks also with fading prompts. Most students had to be reminded to consider the steps to follow in the Big6 Skills, and some had to be reminded of their audience (check whether the text is written so that the fourth graders may understand it), to use strategies for understanding the vocabulary, etc. Most of the students had to be reminded to look at the structure of their text (introduction, main ideas, details, and conclusion). Some students did not manage to complete all 13 topics, which is why the final analysis took into account the reports completed on 11 topics by all students.

Post-Intervention. Groups performed the task individually and independently as at pretest on the topic of weather (Tornadoes). After the last session, the students were asked to choose one or two poster pieces for the Fair poster presentations.

Scoring Reliability

An inter-rater reliability was established for 70% of the sample of written reports. A colleague, blind to the conditions, was provided with the writing rubric. The interrater reliability for pretest was 98% and for posttest was 94% on the measure of writing quality.

Procedural Reliability

Introducing a camera at the beginning of the project seemed intrusive because the computer lab also served as office space for one teacher and one speech-language pathologist. Based on several initial students' reaction to the camera, it also seemed that the students would perceive our sessions as some sort of testing. After I developed a good working relationship with the computer lab teacher and the students, I videotaped two small group sessions. One of these sessions reveals that the students had different needs during the instruction. For example, when asked: "Do you remember what the task is?", one student (control group) responded "No", while another student (treatment) explained: "It is to research the topic you have been asked to do and this is for fourth graders at [name of the school]. They want us to get really good information so we can use it with fourth graders." Also, the first student is heard saying: "This is no fun. I want to do something else." The students also responded differently to the question: What is our task? One student said, "Open the Word", while another responded, "First, we introduce the topic. Then, do research. Open three links. Third, search what's important, and add it right here", and pointed at his notes on the screen. The camera captured the work of the second student who copied and pasted some words (e.g., electricity), but also goes back to the text to rephrase it in his own words. The first student, on the other hand, is heard asking for help with spelling.

Because the students asked different questions and needed different kinds of support, it cannot be stated that they received uniform instruction. However, students within each condition did receive essentially the same instruction as others in the group because I followed a script for task introduction (Appendix D), though this does not guarantee non-contamination between groups. Instruction in the use of the essay

organizer was completed with both groups during the first intervention session. Instruction in the Big6 Skills was completed during the first intervention session for the treatment students, but not all of the treatment students (only 30% did) completed their assigned topic research during the first intervention session. The rest of the treatment group students completed the following steps: (a) task definition; (b) locate sources; (c) access sources; and 4) consider use of the information. Information that seemed useful to the students was typed or copied into a Word document and, in the next session, the students completed their report. Table 2 presents task completion for each topic for the treatment and control groups; the percentage of students who finished the topic assigned in that session is reported. Students who did not complete their task in one session completed it in the next session.

Table 2. *Percentage of students in each group that completed assigned research topic in one session.*

Session	1[a] (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)	8 (%)	9 (%)	10 (%)	11[b] (%)	12 (%)	13 (%)
Treatment	100	30	40	80	100	80	90	100	100	90	100	70	50
Control	100	60	70	90	100	90	100	100	100	90	100	80	80

[a] = pre-intervention session; [b] = post-intervention session

Instruments. Two semi-structured interviews were conducted to capture the way students evaluated their process and the product. The students also were asked to evaluate the Big6 Skills approach to information problem solving. The purpose was to gather data on the students' perception of potential benefits of the Big6 Skills and the students' potential metacognitive development. It was informative to document the students' judgments about the task completion, processes, and products. The answers allowed for a qualitative description of students' metacognitive development.

Artifacts. The students' posters for the Fair were printed out. Students kept their original work in their folders while I kept one printout (or a copy) for further analyses. I also saved copies of the student work on a memory stick. I compared the content of the reports to the original Web pages to compare the amount of copied and pasted work as opposed to information expressed by the students in their own words. Paragraphs completely copied and pasted were not included in data analyses. Copied and pasted information was taken into account when students used data from the Web for their reports but engaged in an effort to add some of their own words (often revealed through misspelling). However, on several occasions, several students copied and pasted information and considered their task complete. The students seemed engaged in reading and considering what to include or not, but finally, several reports reveal no attempt to express the text in their own words. One student copied and pasted an entire report by a person who described a tornado while watching a soccer game and posted it on the Web ("Tornadoes on the Soccer Field", a story by Nicole Gordon, at http://eo.ucar.edu/webweather/story_tornado.html) amounting to 506 words. It seemed important therefore to account for copying and pasting of texts, especially texts such as this one, which do not fit into the category of informational/expository writing and reports. Had the student wrote from her own personal perspective or experience about a tornado on a soccer field (or any other moments), this would certainly count as a part of her report. However, this was not the case, and counting this text as a legitimate text of 506 words, while some of the best and most prolific writers wrote between 125 and 117 at pretest (one control and one treatment student, respectively, and with copying and pasting 320 and 275 words, respectively), would misrepresent what students could do, or

learned to do.

Final activity. At the end of the study, the students picked one or two of their written texts for the Science and Social Studies posters. The students created the titles and decorations for the posters. The school had only one fourth grade class. Due to competing schedules at the end of the school year for elementary students and junior high, we could not organize the actual presentation, but the director of education was willing to organize and coordinate the presentations with the fourth grade teacher during the summer school. I shared with her that the student involvement was partially motivated by the task itself and organizing their presentation was recognized as an important project and culminating activity.

CHAPTER 4

RESULTS

This chapter contains the results of the study and is reported in five sections. The presentation of the results follows the research questions. The research questions asked whether the students receiving the intervention with the Big6 Skills achieved significantly different outcomes in their information problem solving in comparison to the control group as indexed by their writing quality, text length, and navigation. Quantitative analyses addressed these questions. Additional quantitative analyses took into account prior knowledge, motivation, and gender. Qualitative analysis addressed the questions whether the treatment group exhibited metacognitive development through using the Big6 Skill model in their information problem solving and their perceptions of the instruction.

The analyses were performed using a repeated measures analysis of variance (ANOVA). Mauchly's test of sphericity showed homogeneity of the covariance matrix. When there was a significant mean difference, an effect size (ES) was computed as the difference of the posttest mean of the treatment group and the posttest mean of the control group divided by the pooled standard deviation (SD). Following Cohen, 0.20 ES is interpreted as a small size effect, 0.50 is a medium size effect (half a standard deviation difference between means), and 0.80 and above is considered a large effect size (Howell, 2002). All analyses were set at α level of 0.05.

First, descriptive statistics for the control and the treatment group are provided for VIQ/VCI, PIQ/PRI, PC, and TICA in Table 3.

Table 3. *Mean Performance of Students on VIQ/VIC, PRQ/PRI, PC, and TICA.*

Subtests	Control Group		Treatment group		*t*(df)	*p*-value
	M	*SD*	*M*	*SD*	*t*(18)	*p*
VIQ/VCI	97.10	14.36	91.50	11.47	0.96	.35
PIQ/PRI	101.40	21.78	92.30	15.60	1.07	.30
PC	85.10	8.71	82.90	6.04	0.66	.52
TICA	19.80	0.42	19.30	1.25	1.20[a]	.26

[a]Equal variances not assumed, degrees of freedom for the *t*-test = 11.02.

Given these variables, the control and the treatment groups were considered to be comparable, indicating that parametric statistical analyses could be performed.

Research Question A

Research question A asked whether there is any significant difference in writing quality (measured with the RAFT rubric) between the control and experimental groups. Descriptive statistics for pretest and posttest means on the RAFT writing quality rubric indicate that the control group received on average higher scores at pretest (M=9.20, SD= 2.66) than the treatment group (M=7.80, SD= 2.57), but the treatment group received higher scores at posttest (M=13.20, SD=2.62) than the control group (M=12.30, SD=2.83).

A repeated measures analysis of variance (ANOVA) showed that there was a significant difference between pretest and posttest scores for both the control and the treatment group in writing quality, $F(1,18) = 38.41, p < .001$ (see Table 4). However, the interaction between time of testing and group was not significant.

Table 4. *Analysis of Variance for Writing Quality*

Source	*df*	*MSE*	*F*	*p*
Time	1	180.625	38.41	< .001*
Time x Group	1	13.225	2.81	.111
Error	18	(4.7)		

Writing quality was measured on four traits: topic focus, organization, sentence length and variety, and mechanics (CUPS) of language use. Paired samples *t*-tests were performed on these measures. There were significant differences in posttest scores for the treatment group on three measures: topic focus, $t(9)= -7.57$, $p= .001$, organization quality, $t(9)=-4.33$, $p= .002$, and sentence length and variety, $t(9)=-3.10$, $p= .013$. There were significant differences in posttest scores for the control group on two measures: topic focus, $t(9)=-3.97$, $p= .003$, and sentence length and variety, $t(9)=-7.57$, $p= .001$.

Research Question B

This question asked whether the treatment students wrote significantly longer texts than the control students. Descriptive statistics for the means of pretest and posttest text length indicate that the control group on average used more words in their reports at pretest ($M=63.20$, $SD=31.09$) than the treatment group ($M=48.80$, $SD=35.19$). However, the treatment group almost doubled the number of words from pretest to posttest ($M=92.20$, $SD=49.03$), while the control group used fewer words at posttest ($M=54.50$, $SD=38.74$). Accordingly, a repeated measures ANOVA showed a significant difference

between the groups in text length, $F(1, 18) = 13.09, p = .002$ (see Table 5), with a large effect size (ES= 1.70). Figure 8 displays a graph of the pretest and posttest means for text length and the interaction of time (pretest, posttest) and group (treatment, control).

Table 5. *Analysis of Variance for Text Length*

Source	*df*	*MSE*	*F*	*p-value*
Time	1	6027.025	7.13	.016*
Time x Group	1	11055.62	13.09	.002*
Error	18	(844.71)		

Research Question C

This question asked whether the treatment group opened significantly more links in comparison to the control group. Descriptive statistics for the means at pretest and posttest for navigation scores indicate that the control group on average opened more links during their searches at pretest (M=1.40, SD=0.70) than the treatment group (M=1.20, SD=0.63). However, the treatment group on average almost doubled the number of links opened from pretest to posttest (M=2.30, SD=0.82), and the control group scored lower than the treatment group at posttest (M=1.90, SD=0.88).

A repeated measures ANOVA for navigation showed a significant change between the pretest and posttest for the control and the treatment groups, $F(1, 18) = 14.96, p = .16$ (see Table 6), though the interaction between the time and group was not significant.

Figure 8. Display of Pretest and Posttest Means of Text Length

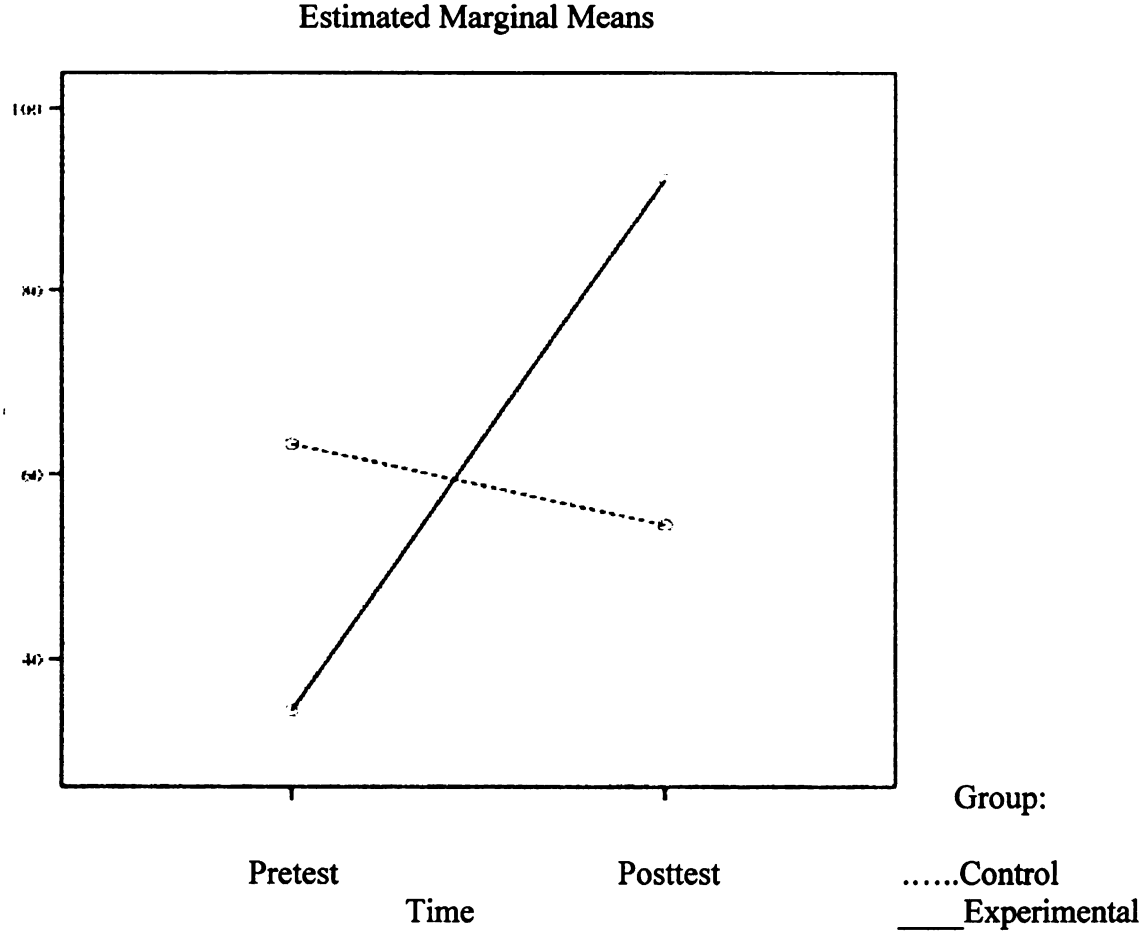


Table 6. *Analysis of Variance for Navigation*

Source	*df*	*MSE*	*F*	*p-value*
Time	1	6.40	14.96	.001*
Time x Group	1	.90	2.10	.16
Error	18	(.43)		

In regard to navigation, there was no significant difference between the groups at pretest, $t(18)=.67$, $p=.51$, and posttest, $t(18)=-1.05$, $p=.31$.

Analyses Related to Prior Knowledge, Motivation, and Gender

Correlational analysis of prior knowledge. Because there are some mixed results in the extant research related to prior knowledge, additional analyses addressed the relationship between text length, writing quality, navigation, and prior knowledge. The correlations are summarized in Table 7.

Table 7. *Correlations for Text Length, Writing Quality, Navigation with Prior Knowledge*

	Pretest Prior Knowledge R^2 (*p*-value)	Posttest Prior Knowledge R^2 (*p*-value)
Control		
Pretest Text Length	.08 (.82)	.32 (.38)
Posttest Text Length	-.23 (.52)	.27 (.46)
Pretest Writing Quality	-.24 (.51)	.22 (.54)
Posttest Writing Quality	-.37 (.29)	.17 (.65)
Pretest Navigation	-.75* (.01)	-.67* (.03)
Posttest Navigation	-.72* (.02)	-.27 (.45)
Treatment		
Pretest Text Length	.45 (.20)	.36 (.31)
Posttest Text Length	.48 (.15)	.28 (.44)
Pretest Writing Quality	-.02 (.96)	.21 (.57)
Posttest Writing Quality	.07 (.86)	-.43 (.21)

Pretest Navigation	-.31 (.39)	-.46 (.18)
Posttest Navigation	.24 (.51)	.06 (.87)

Note. Numbers indicate eta-squared followed by p-values enclosed in parenthesis.

There were no significant correlations for the groups related to text length or writing quality and prior knowledge. There was a significant moderate correlation between prior knowledge and navigation scores at pretest for the control group. There was no significant difference between the groups in prior knowledge at pretest, $t(18)=0.45$, $p=.66$, or posttest, $t(18)=-0.48$, $p=.63$ (see Table 8). The total points possible for prior knowledge was 5.

Table 8. *Mean Numbers of Correct Responses Related to Prior Knowledge*

	M (SD)	*t* (18)	(*p*-value)
Pretest Treatment Group	3.80 (.92)		
Pretest Control Group	4.00 (1.05)	.45	(.66)
Posttest Treatment Group	4.20 (.92)		
Posttest Control Group	4.00 (.94)	-.48	(.63)

Motivation. During this study, most participants expressed that they did not like to read or write but many of them nonetheless expressed that they liked doing research for the fourth graders. A few students rather consistently gave low scores of 1 on all questions because they perceived our sessions as "very hard" work.

The first question in the questionnaire related to motivation asked the students to what extent, on the scale from 1 to 5, they were interested in reading and learning about a certain topic (Q1); the second question was related to their interest in researching the topic on the Internet (Q2); the third question probed the extent to which the students were interested in learning about the topic in question from some other sources (e.g., teachers, parents, friends) (Q3); and, finally, the fourth question asked to what extent they would like to write about the topic in question for the fourth graders (Q4).

Descriptive statistics for the control and the treatment group for motivation across all the topics and questions are presented in Table 9, along with the results of the *t*-test analyses for the two groups.

Table 9. *Means of Students' Responses to Motivation Questionnaire*

Source	Group	n	*Mean*	*SD*	*t*(18)	*p*-value
Weather Q1	Control	10	4.00	.94		
	Treatment	10	3.40	1.51	1.07	.30
Weather Q2	Control	10	4.00	1.05		
	Treatment	10	3.50	1.08	1.05	.31
Weather Q3	Control	10	4.20	1.03		
	Treatment	10	3.70	1.42	.91	.38
Weather Q4	Control	10	4.10	.99		
	Treatment	10	4.00	1.16	.21	.84
Branches of the government Q1	Control	10	3.40	1.17		
	Treatment	10	1.90	.88	3.24**	.01
Branches of the government Q2	Control	10	3.10	1.29		
	Treatment	10	3.20	1.48	-.16	.87
Branches of the government Q3	Control	10	3.90	1.20		
	Treatment	10	2.90	1.60	1.59	.13
Branches of the	Control	10	3.90	1.45		

	Treatment	10	3.50	1.65	.58	.57
Electricity Q1	Control	10	3.40	1.51		
	Treatment	10	3.10	1.29	.48	.64
Electricity Q2	Control	10	3.10	1.20		
	Treatment	10	3.30	1.57	-.32	.75
Electricity Q3	Control	10	3.10	1.60		
	Treatment	10	3.70	1.57	-.85	.47
Electricity Q4	Control	10	3.30	1.42		
	Treatment	10	3.40	1.58	-.15	.88
Constitution Q1	Control	10	3.70	1.25		
	Treatment	10	3.30	1.34	.69	.50
Constitution Q2	Control	10	3.00	1.49		
	Treatment	10	2.90	1.20	.17	.87
Constitution Q3	Control	10	3.90	1.66		
	Treatment	10	3.80	1.32	.15	.88
Constitution Q4	Control	10	3.90	1.29		
	Treatment	10	4.10	1.37	-.34	.74
Presidents Q1	Control	10	3.50	1.35		
	Treatment	10	3.40	1.71	.15	.89
Presidents Q2	Control	10	3.60	1.35		
	Treatment	10	3.10	1.66	.74	.47
Presidents Q3	Control	10	3.50	1.35		
	Treatment	10	3.50	1.65	.00	1.00
Presidents Q4	Control	10	3.90	1.20		
	Treatment	10	3.60	1.71	.45	.66
Elec. Safety Q1	Control	10	3.10	1.60		
	Treatment	10	3.50	1.27	-.62	.54
Elec. Safety Q2	Control	10	3.10	1.60		
	Treatment	10	3.50	1.65	-.55	.59
Elec. Safety Q3	Control	10	3.00	1.33		
	Treatment	10	2.90	1.72	.15	.89
Elec. Safety Q4	Control	10	3.60	1.43		
	Treatment	10	3.40	1.71	.28	.78
Symbols of the	Control	10	3.40	1.17		

	Treatment	10	3.30	1.57	.16	.87
Symbols of the	Control	10	3.20	1.49		
Government Q2	Treatment	10	3.30	1.49	-.15	.88
Symbols of the	Control	10	3.60	1.43		
Government Q3	Treatment	10	3.30	1.49	.46	.65
Symbols of the	Control	10	4.00	1.16		
Government Q4	Treatment	10	3.80	1.75	.30	.77
Electrical Past &	Control	10	3.10	1.20		
Present Q1	Treatment	10	2.70	1.34	.71	.49
Electrical Past &	Control	10	3.00	1.25		
Present Q2	Treatment	10	3.10	1.45	-.17	.87
Electrical Past &	Control	10	2.80	1.40		
Present Q3	Treatment	10	3.30	1.25	-.84	.41
Electrical Past &	Control	10	3.50	1.58		
Present Q4	Treatment	10	3.70	1.57	-.28	.78
Magnets Q1	Control	10	3.50	1.43		
	Treatment	10	2.80	1.48	1.08	.30
Magnets Q2	Control	10	3.20	1.55		
	Treatment	10	3.10	1.66	.14	.89
Magnets Q3	Control	10	3.00	1.33		
	Treatment	10	3.10	1.60	-.15	.88
Magnets Q4	Control	10	3.70	1.25		
	Treatment	10	3.20	1.63	.77	.45
Conductors Q1	Control	10	3.40	1.51		
	Treatment	10	3.20	1.62	2.89	.78
Conductors Q2	Control	10	3.20	1.48		
	Treatment	10	3.50	1.30	-.48	.63
Conductors Q3	Control	10	3.30	1.70		
	Treatment	10	3.70	1.64	-.54	.60
Conductors Q4	Control	10	3.70	1.42		
	Treatment	10	3.60	1.71	.14	.89
Tornadoes Q1	Control	10	4.00	1.33		
	Treatment	10	3.80	1.55	.31	.76
Tornadoes Q2	Control	10	3.90	1.20		

	Treatment	10	3.70	1.64	.31	.76
Tornadoes Q3	Control	10	3.80	1.48		
	Treatment	10	3.10	1.45	1.07	.30
Tornadoes Q4	Control	10	4.20	1.23		
	Treatment	10	3.80	1.75	.59	.56

Descriptive statistics show that the students rated the task (Q4: writing for the fourth graders) the highest (M=3.72, SD=1.21). Differences between the control and treatment students related to motivation across the topics were not significant, except for the topic of the three branches of the government. The control group expressed significantly higher interest in this topic, $t(18)$=3.24, p=0.01. Correlations for motivation related to the topic of research and prior knowledge are presented in Table 10.

Table 10. *Correlations for Motivation and Prior Knowledge*

	Pretest Prior Knowledge R^2 (p-value)	Posttest Prior Knowledge R^2 (p-value)
Control		
Pretest Motivation	-.45 (.19)	-.25 (.49)
Posttest Motivation	-.24 (.51)	.00 (1.00)
Treatment		
Pretest Motivation	-.42 (.23)	-.79** (.01)
Posttest Motivation	-.50 (.14)	-.52 (.13)

**Correlation significant at the 0.01 level.

There was a significant correlation between the prior knowledge and the scores on the Likert motivation scale for the treatment group on the pretest topic of weather.

Gender analysis. The literature review reveals some mixed results related to gender and learning with hypertext. A *t*-test was performed for the gender group analyses. Table 11 provides descriptive statistics for the means of gender at the pretest and posttest.

Table 11. *Means for Gender at Pretest and Posttest for Writing Quality, Text Length, and Navigation*

Source/Gender	*M*	*SD*	*t*(18)	*p*
Pretest				
Writing Quality				
Male	9.40	2.75		
Female	7.60	2.32	1.58	0.13
Text Length				
Male	57.80	45.56		
Female	39.80	18.95	1.15	0.26
Navigation				
Male	1.30	.67		
Female	1.30	.67	0.00	1.00
Posttest				
Writing Quality				
Male	13.40	2.59		
Female	12.10	2.77	1.08	0.29

Text Length				
Male	86.90	52.60		
Female	59.80	38.95	1.31	0.21
Navigation				
Male	2.20	.79		
Female	2.00	.94	0.51	0.61

There were no significant differences in the scores for writing quality at pretest, $t(18) = 1.58, p = .13$, or at posttest, $t(18) = 1.08, p = .29$, related to gender. Also, no significant difference were found between girls and boys in text length at pretest, $t(18) = 1.15, p = .26$, or at posttest, $t(18) = 1.31, p = .21$, or in navigation at pretest, $t(18) = 0.00, p = 1.0$, or at posttest, $t(18) = 0.51, p = .61$.

Research Question D

One of the interests in this study was whether scaffolding students in research on the Web through the Big6 Skills steps would contribute to students' metacognitive development related to information processing skills. A semi-structured questionnaire was orally administered to the treatment students two times, at the mid-point and end of the study. The qualitative analysis of the semi-structured questionnaire revealed that the treatment students exhibited some development of their metacognitive awareness of regard to the process and the products related to their Web searches.

Product/Process. The first question asked the students to evaluate their work and to evaluate whether they think they did what was required. Most students thought that they did well. Some students were focused on evaluating the product in answering this question, while some were focused on the process. For example, one student focused on the product and noted: "As a grade, I did 'medium'. The report would be better if I used

more information." The same student noted toward the end of the project that she "did a good job, as 'five' on the scale from one through five" because she "used a lot of information." Several students were more focused on the process and referred to their use of resources in evaluating their performance. For example, one student noted: "Yes, I looked at various information sources and understood how to use them." One student responded, "Yes, I checked on one source and wrote about it, then I checked another source..."

Skills. In regard to the potential skills that the students learned and could use in the future, some students referred to the online search skills, while some focused on the writing skills. For example, several students noted, "I learned to use various sources." Some students noted, "I learned to use research skills, finding information that I understand." "I learned to look into further links." "I learned how to use the switch [on the screen] so I can see how circuits go through the wires." Those who referred to their writing noted that they could use the skills they employed in their writing. For example, "I learned that I should have a conclusion." "I learned taking notes." "I learned to pay attention to spelling and grammar." Several students noted that they learned to go to their texts "back and forth". For example: "I learned to go back and forth..." and, "You always have to go back to your report because you still have to see whether it is good. This is a good tool for everybody who has to write. So I can use it if I have to do essay again."

When asked to evaluate their work and skills over time, several students were able to evaluate why their report was better at the second evaluation, which occurred toward the end of the study. For example, one student noted, "Yes, the more information that can

be understood, the better it is. I fixed the report, organized it, and used the words that can be understood by fourth graders." When asked what they would do differently next time, most students stated that they would write "a longer piece," "get more information," "I could be better... the better order, like take notes and then look what's most important..."

Research Question E

One of the questions on the semi-structured questionnaire asked the students in the treatment condition whether they perceived any benefits in implementing the Big6 Skills approach to information search and management. All of these students responded that they found the Big6 Skills useful and provided a number of reasons: "It keeps me on track." "I can follow the steps." "It makes it easier to understand how to do a report." "It's helpful. It could get more difficult so it's there when you need it." "So that I can do the best job I can." Similarly, several students noted that it is helpful because you know which steps to follow "as a reminder." Also, "It provides steps so that I can do a full report. I can use it in my other kind of reports." When asked to provide an example of other reports, this particular student said, "projects—like we did on South America." However, in spite of all the positive comments that these students had to share about the Big6 Skills, they did not learn to use it independently.

I started each session with the treatment students by asking them whether they remembered what their task was. Depending on their answers, I would share additional information. Some students answered, "to write a report", "to search information for fourth graders", etc. For those students who seemed to lack awareness of their audience, I would remind them that the report is a part of the Social Studies and Science Fair posters to be presented to fourth graders. I would remind the students to use the essay organizer

and check their understanding of the purpose of the organizer. Although the students uniformly seemed to understand the purpose when asked about it, they also almost uniformly did not engage in reading and following instructions presented on the visual organizer. As already noted, these students were not used to independently using visual organizers. Their work in the computer lab was to a large degree dedicated to typing up information that they already gathered in the library guided by the librarian, a teacher, and at least one paraprofessional. While their studying in this project was intended to help them develop a metacognitive awareness about the Big6 Skills steps, the task might have presented too much of a novelty for them or may have not been taught for a long enough period of time for them to demonstrate independent proficiency.

CHAPTER 5

DISCUSSION

This chapter summarizes and discusses the findings of the study. The discussion includes some theoretical and instructional implications, along with the limitations of the study, followed by a conclusion.

Summary and Discussion of the Findings

This study was designed to investigate whether students with LD could be supported in their searches on the Web and writing reports on topics in social studies and science. With increased recognition that literacy skills include not only reading and writing, but also information processing skills and technology use, a repeated measure design was used to examine the effects of intervention in text search and information management. The treatment and the control group significantly improved on the measures of writing quality and navigation, with the treatment group significantly outperforming the control group on the measure of text length.

It was anticipated that: (a) students in the treatment condition would write qualitatively better expository texts; (b) students in the treatment condition would write longer expository texts; (c) students in the treatment group would improve in their navigation of web sites by opening more links; (d) students in the treatment condition would increase their metacognitive awareness related to their information problem solving; and (e) students would perceive instruction in information problem solving with the Big6 Skills as beneficial.

A repeated measures ANOVA showed that there was a significant difference between pretest and posttest scores for both the control and the treatment group in writing quality. Both the treatment and the control groups were provided with the essay map organizer and were instructed to use it for the purposes of organizing their written reports, while the treatment group was also instructed in the Big6 Skills model of information problem solving. Writing quality was measured on four traits: topic focus, organization, sentence variety, and the mechanics of language use (capitalization, punctuation, and spelling). Paired samples *t*-tests indicated that there were significant differences in posttest scores for the treatment group on three measures: topic focus, organization, and sentence length and variety. There were significant differences in posttest scores for the control group on two measures: topic focus and sentence length and variety. There were no significant posttest score differences in the mechanics of language use for either group. In the work performed by the treatment group, instructed in the Big6 Skills steps, step four of the Big6 Skills asked the students to organize selected information. In the process of looking at their notes and organizing their information, some students iteratively reviewed their texts, expanded them, and organized them in a more coherent manner.

The results of this study also show that the treatment group wrote even longer texts following instruction than the control group. The results on the measure of text length were significant, with an interaction effect for group, with a large effect size (ES=1.7). It seems that the fourth step of the Big6 Skills (organize your information) and the fifth step (synthesize), supports writing as a recursive process. Possibly, these students might have had engaged in further revisions if the sixth step (evaluate your

product and process) was followed more systematically. However, often there was not enough time within one school period to systematically incorporate the sixth step.

In regard to the text length, it seems important to illustrate how reports written by the same student might differ dramatically, whether the word count gain is minimal (as in the writing of the control student GK: +1 word), or quite large (+135), as illustrated by the writing of JB (a treatment student).

Student: GK

Pretest: (March, 2009; word count = 55)

In the first section, I read about how much floods of rain dropped.

When I read the second section, the thunderstorms are very dangerous, but came from the west coast.

Lastly, the bolts of lighting are higher than any lightening thunderstorms. I dislike when it's rain, or thunderstorms. This is dangerous for people right now.

This report indicates that the student opened all three links on the Web portal at pretest, but her report was much more coherent at posttest. Her report completed during the posttest follows.

Posttest: (June, 2009; word count = 56)

Tornadoes

This report is about Tornadoes.

Tornadoes cause heavy rains, warm, moist air and lightenings too. Tornadoes always destroy houses, stores, banks, and other buildings. Tornadoes can also kill people and animals too.

If you think that there is a tornado coming, then this is the time to turn your radio or your television.

While the text length is approximately the same for the two reports, the posttest report seems to be much more coherent: it includes the topic title, it reads as an expository piece as opposed to a list-like writing as on the pretest sample, and the concluding sentence includes an awareness of her audience.

Consider also the coherence of the texts on pretest and posttest, a measure not used on the rubric, completed by one student from the treatment group.

Student: JB

Pretest: (March, 2009, word count = 23)

Weather

Lighting and Thunder are very dangerous you could dye from it. Lighting is a bright flash of electricity produced by a thunderstorm.

Posttest: (June, 2009, word count =157).

Tornadoes by (pseudonym)

Today I will write about tornadoes. When you are at a school you bend your head down on a wall and you don't talk with anyone during a tornado, when you are in a car you get out of the car and you go to a low spot in the ground. Tornadoes are really dangerous and they can kill you either outside or inside. When a tornado occurs then people should be in a basement, bathroom, or something without windows.

A tornado is a form of air and how its made is that there is warm air. A tornado is caused by thunderstorms. Tornadoes can come from any direction. Some of them change

direction. Tornadoes are so fast and they spin fast you don't want to be in the middle of one.

The most tornadoes come in Texas, and sometimes in Minesotta aslo. Always remember that you have to hide and you are important not electronics.

The net gain in text length of this student is quite remarkable. While the first sentence from the posttest writing might seem to come from her prior knowledge, the second and third paragraphs are related to her online search, her conclusion gives a set of directions related to her audience.

The net gain for the treatment group varied from plus one word to plus 167 words, with only one student having a net loss of one word. The net gain for the control group varied from the net gain of 44 words to a net loss of 63. Overall, the majority of the students wrote a sentence, a couple of sentences, or a short paragraph at pretest, while the writing at posttest was longer in the treatment group, who also showed an increased awareness of the audience. Here are some examples: "This is a report for the fourth graders"; "Always remember that you have to hide and you are important, not electronics"; "You should always listen to the forecast so you know when there's a tornado"; "When you live in warm weather, then beware of the lightning"; "Turn your light off because you save money"; "Next, you are going to learn about parallel circuits"; "Last, you are learning about series circuits". In writing their reports, both groups of students engaged in copying and pasting. The text blocks that were copied verbatim from Web pages were excluded from the analysis of text length. The treatment and the control groups did not differ in the amount of text (number of words) they copied and pasted at pretest, $t(18)=-.06$, $p=.96$, or at posttest, $t(18)=-1.24$, $p=.23$.

In the present study, the students engaged in an increased practice of writing and completing one report per topic in one or two sessions. Some of the students, as revealed through a qualitative analysis and field notes, learned to go back and forth to their texts, in order to revise them, and make them more understandable to their audience. It may therefore also be assumed that increased writing practice contributed to large gains, in addition to instruction. The gains in writing may also partially be contributed to the task itself. Many students stated that they did not like to write or read, but considered the task important "...because it is really important for fourth graders to know about our Constitution...", or "...because it is really important for the fourth graders to know how to avoid electric shock," etc.

Several additional aspects should be considered in the discussion of the results, as revealed through the field notes. The writing instruction in the school—the site of this study—followed a prescribed curriculum in which students were taught various steps of writing and were engaged in practicing certain skills. For example, in mini-lessons on descriptive writing, the students might be presented with a picture of a boy, and then asked to describe the boy by using several adjectives. The students also practiced paragraph writing with a house as a scaffold: a foundation stands for the main idea, walls for details, and a roof for the conclusion. The students did not necessarily perceive these exercises as writing per se. When asked about writing, some students indicated that "on Fridays, we do heroes' poems, favorite restaurants, etc..."

Although students with LD benefit from explicit instruction, such instruction may also lead to treating writing as a distinct element in the curriculum. Such an approach may convert the writing process into a set of procedures (Nystrand, 2001). Also, the solid

house metaphor of paragraph writing stands in contrast to writing as a recursive process (Hayes, 1996). The findings of this study reveal that the students benefited from using organizing frameworks: the Big6 Skills as a scaffold for the steps needed to be performed in research and writing reports, and the essay map, showing that a piece of writing should include an introduction, main ideas, details, and a conclusion. These findings seem important in view of Englert's (2009) suggestion that more instructional studies should be conducted to better inform teachers who use heuristics and routines in their literacy instruction.

In regard to navigation, it should be noted that both groups opened a limited number of the Web pages at pretest, although it was explained to them that they should explore the Web resources, and these resources were pointed to on the screen. A repeated measures ANOVA for navigation showed a significant change between the pretest and posttest for the control and treatment groups. Although the students opened more links at posttest, the actual number of links opened remained small when students were left to explore on their own. Therefore, it is not clear how to interpret a significant moderate negative correlation for the control group between prior knowledge and navigation scores at pretest. One possible explanation might be that prior knowledge might actually preclude hypertext explorations as some students might rely more on their background knowledge. This might be unique to students with LD who engage in limited reading for the purposes of accomplishing their tasks. Because number of nodes accessed (i.e., links) is related to knowledge acquisition (e.g., Salmerón et al., 2005), this outcome for the present study indicates that teaching students the importance of accessing more than one or two online sources while learning with the Web is essential. However, the findings in

this study related to navigation also seem to be related to the design of the Web pages, a feature only superficially addressed here. Some Web pages seemed to be designed to invite a reader to interact (e.g., click on an image) and those seemed to be especially attractive to the students in this study (e.g., http://www.miamisci.org/af/sln/frankenstein/safety.html). For example, data for the topic of electricity show that the students opened on average a higher number of links and hyperlinks for that topic (M =4. 55, SD =2.70), as opposed to those presented at pretest (M= 1.30, SD=0.66) or posttest (M=2.10, SD=0.85). While most of the sessions were conducted individually, due to competing schedules at mid-point of the study, two sessions consisted of two students and two sessions of four students (one with treatment students and one with control), so precise data during instruction related to number of links opened was difficult to attain.

In addition to Web design, the preference for certain topics might have been related to the student current situation. For example, "I just learned about that [Constitution] in social studies" would indicate that a student might not be interested in investigating further while, on the other hand, a student might read about electrons and note excitingly: "I never knew that", and seek to explore the related sites in depth. Additional analyses were performed that took into account prior knowledge and motivation. Overall, there were no significant correlations for prior knowledge and writing quality, text length, and navigation. No significant differences in the students' outcomes were related to gender, although the boys scored higher at pretest and posttest on these measures.

The students seemed to be motivated to complete the task because they were engaged in informing fourth graders in their school about their findings. The results

indicate that the students had more interest in doing research and writing for their peers (M =3.72, SD =1.21) than they had in the topics explored (M =3.31, SD =1.07), although the difference was not significant. Motivation is an under-researched topic in education (Greeno, Collins, & Resnick, 1996), yet important for student engagement (Troia et al., in press). Some students commented, while assigning a low number on the Likert scale related to the task, "I like the idea of [doing] research for the fourth graders, but writing is hard", or "I like this [Web] research for the fourth graders, but not the typing...". Therefore, even when students assigned a low number to the task (of developing Social Studies and Science Fair posters for the fourth graders), some students distinguished the part of doing research for the fourth graders, which they viewed positively, from writing their reports, which they viewed negatively. Students who experience difficulties in reading often experience difficulties in writing. Creating tasks in which the students read with a certain purpose and write for an audience beyond the teacher seems especially important when working with students who might experience difficulties in these two areas. Based on the field notes, it seems that those students who struggled with spelling would be the first candidates for abandoning the project, and consequently, some of them consistently rated all of the points on the motivation scale low because they perceived reading and writing as "hard work".

The ability to temporarily retain information while processing other incoming information plays an important part in reading (Swanson et al., 2000), and this ability, as noted earlier, may be particularly important for hypertext reading in view of its multimodality. The Big6 Skills helped the students in view of the complex steps required for researching, reading, and writing. All the students were uniform in acclaiming the

Big6 Skills was useful because it kept them on task or simply made their work easier because they could follow the steps, refer to them as necessary, etc. Yet, it also seems important to note that the students never took "ownership" of the steps. In a sense, I was their scaffold, rather than the scaffold itself. On two occasions I added the same Big6 Skills steps with a bit more textual elaboration (another version of the Big6 Skills), but that strategy also did not seem to work. Providing more (written) information to the students with LD in reading might simply be counterproductive. Therefore, while the results were significantly different for the treatment group that used the Big6 Skills steps on the measure of text length and text organization, it also seems that another scaffold, perhaps with fewer steps, could be implemented. On the other hand, it could be that the step six of the Big6 Skills should be practiced consistently because it asks the students to evaluate their work. At that point, students might consider further revising of their texts and, at the same time, might become more cognizant of the strategies that worked (or not) during their interaction with the Web, information processing and management. In this sense, developing metacognitive awareness is an important aspect in learning. Developing metacognitive awareness is akin to developing habits of mind where students would learn to regularly evaluate their work and is something that should probably be taught throughout the school year.

Theoretical Implications

Findings from this study extend the work on writing from multiple sources and a new literacies theory of reading (e.g., Leu et al., 2004, Leu et al., in press) according to which reading and writing are still viewed as central to literacy, but new strategies for the location, evaluation, and use of information are required. Reading has been, and

continues to be, predominantly discussed as text decoding and text comprehension, especially when considering students with LD (NICHD, 2000). In addition, reading is often examined as a process on its own, rather than a process that serves a certain function: read to learn, read to function in a society, read to write (communicate), etc. By examining reading as online information problem solving, reading activities become inquiry activities.

The findings from this study confirm that students involved in learning with the Web need training and support in search skills and management of information (Kuiper et al., 2005). Hypertext reading involves constructing a text and in that sense is different from reading as interpreting texts. Approaching reading as information problem solving (Eisenberg & Berkowitz, 1999) allowed the treatment students in this study to become more strategic learners, as indicated through an open-structured questionnaire. These findings are in line with a large body of research (e.g., Dreher et al., 1997; Englert et al, 1991; Gersten et al., 2001) that shows that explicit instruction in strategic learning and thinking helps students to overcome their difficulties. The findings related to increased quality of writing by both groups as measured by the rubric are also in line with previous research that documents positive effects of visual organizers for students with LD (e.g., Kim, Vaughn, Wanzek & Wei, 2004).

In creating authentic tasks for K-12 students, it is possible to engage students with difficulties in reading and writing in literacy activities. In online literacy activities, students construct their own path to text construction and comprehension. Increased navigation results in an increased access to and location of information (Salmerón et al., 2005). In the process, both offline and online strategies are employed: readers might read

texts in a linear fashion on the screen, but also read images, icons, and multiple texts. In this sense, it seems important to extend our knowledge of reading as a semiotic process, in addition to our understanding of reading as a linguistic process (e.g., Kress & van Leeuwen, 2006).

As technology reshapes our notion of what constitutes "basic skills", learning with the Web calls for instruction in which reading, writing, and informational skills should be viewed as interconnected. This interconnection might be especially important for students with disabilities who are sometimes taught skills in isolation. It is important to reiterate here that instruction in offline reading and writing should likewise be interconnected, one of the points stressed in Englert's (2009) recent work. Otherwise, transporting students into the new paradigms for learning may simply compound their difficulties (Leu, Kinzer, Coiro, & Cammack, 2004) and add more skills to be practiced in isolation.

Along with computer labs in some schools, there are often separate library rooms. As new environments for learning are established separately from the older ones, a division between the searches for information, managing information, reading, and writing might also be practiced separately rather than integratively. As noted earlier, the students in this study did their research in the library, then wrote up their reports on the worksheets and then typed their reports in the computer lab. Such a division in the steps of learning (to conduct research, manage and organize the results, and then write information) does not seem to fit into the new paradigms of learning or developing 21st century skills. A report on 21st century skills (Casner-Lotto et al., 2006) reveals that the

"three Rs" are still fundamental to new workforce entrants but that applied skills, such as competencies in information technology (IT) applications, are also very important.

The way teachers understand and implement theories of literacy affects students' understanding of what counts as literacy (Jewitt, 2008). What counts as literacy in our contemporary society has dramatically changed over the last century (Resnick & Resnick, 1977) and the term literacies rather than literacy might better capture this change. Re-theorizing literacy, therefore, has implications for instruction, to which I turn next.

Instructional Implications

This study confirms that informational problem solving tasks might be amenable to instructional efforts (e.g., Symons et al., 2001). The students with LD and learning difficulties benefited from instruction related to search, selection, and organization of information found on the Web. Research on instruction in the Web environments could benefit from examining the implementation of the Big6 Skills systematically (i.e. allowing enough time to attend to the sixth step). Because the sixth step refers to reflective questions on a product (e.g., report) and a process (e.g., strategies in search), this step seems crucial for metacognitive development of students with LD. This study also underscores the importance of motivation through establishing carefully constructed tasks that involve an audience beyond the teacher.

This study confirms the importance of scaffolded instruction in instructing students with LD (Stone, 1998; Englert, 2009). Through scaffolded instruction, using the Big6 Skills and the essay map, the treatment students' writing quality significantly increased on three measures (topic focus, organization, and sentence variety). The text length also significantly increased. Because the use of the Big6 Skills benefited the

students, it seems that this theoretical information problem solving model might have useful application in instruction beyond this study. When applied in practice, however, it also seems that theoretical models could be adapted to better accommodate diverse learners.

In learning with the Web, there are still skills related to traditional literacy skills such as comprehending and evaluating important information in texts. Learning with the Web environment, however, should change literacy instruction. With ever expanding links and authors behind the links, learning with the Web becomes more complicated than learning with a textbook approved by the district. Learning with the Web might not start with finding the main ideas first, but to search first of all for a reliable source. This form of learning does not seem to be taking place on a daily basis in the schools but is an important part of learning with the Web (Coiro, 2007).

On the other hand, in this era of accountability, teachers might question the utility of instructional processes that do not lend themselves directly to improving scores on state tests. With an increased number of schools proclaimed "failing", there is a turn to talking about "demographics", not as data that should require teachers and principals to consider differentiated instruction, but it seems to function as a code word for "problems" (Curcic, Gabel, Zeitlin, Cribaro, & Glarner, in press). Ironically, the students in the 21st century may be guided to a path of "three Rs" (Reading, Writing, and Arithmetic) rather to the 21st century skills. As Hartman (2000) noted almost a decade ago, "what constitutes literacy is already being reshaped by the influence of media" (p. 281). The curriculum, however, seems to be less reshaped, with some tendencies toward becoming more—rather than less—essentialist worldwide, including the U.S. (Tamatea, 2005).

Research on online reading suggests that hypertext may present material that is more difficult to read than print material for both experienced and competent readers as well as less able readers (e.g., Coiro, 2007; McEneaney, 2003). The students in the present study varied in reading and writing strategies. Some students who showed modest gains in, for example, scores on text length, were more skillful than some other students before this study began. The complexity of learning with the Web calls for a much more nuanced understanding than currently offered.

Limitations of the Study

The study was conducted predominantly with the researcher as the instructor in a number of individualized sessions. Most sessions were truly individualized because they were predominantly conducted one-on-one, and also because the researcher responded to the unique questions of each participant. Thus, treatment fidelity was potentially compromised and so the findings of this study must be viewed as tentative at best.

The number of topics was limited to 13 because of: (a) the number of students involved, (b) the session scheduling took into account each student's schedule so that the student would not miss the introduction of new concepts in his or her classes, and (c) the end-of-the-school year competing schedules. The students' gains would perhaps be larger over an even more extended period of time.

The school where the study took place accommodates predominantly students with LD and, in that sense, does not necessarily resemble other school settings, public or private, which limits the generalizability of the findings. Because the students were matched on several characteristics related to their cognitive abilities, reading performance, and facility with technology, the results might be generalizable to students

with a reading disability. However, this population is not as homogeneous as it sounds, and the outcomes might differ for different groups of students with LD. It also should be noted that two students had concomitant ADHD, and a few students had low VIQ scores, and consequently, the results might be less generalizable than otherwise.

The students were presented with predetermined and loaded links within the Google account rather than having an option to research freely on the topics. Although this approach resembles many schools' approaches to Internet instruction, it also should be noted that the task as constructed might be limiting. For example, two students wanted to conduct separate searches for images on Google, but I discouraged those explorations so that all the students were presented with the same sources of information. Also, the task required writing, and this part did not seem to be particularly appealing to a number of students.

Using the Big6 Skills with the essay map resulted in writings that were much more structured than the writings of the students created at pretest. Some of the best writing pieces, however, occurred at the mid-point of the project. Although at this point the students were still guided in their projects, it is also true that toward the end of the school year students seemed to be less focused. Thirteen topics appeared to be quite demanding for the students, because they were involved in other reading and writing projects as part of the standard curriculum. Also, the school engaged students in a variety of activities (plays, music performances) that needed extra-curricular hours. Embedding the task involved and the Web research over the entire school year might have seemed more natural, and resulted in even larger gains in these students' outcomes. Instruction conducted over an extended time period would also allow time to teach students to

critically evaluate information they found on the Web as proposed by advocates of a new literacies framework (e.g., Coiro, 2007; Leu et al., 2006). Although the strategies proposed by these scholars are similar to the information problem solving employed in this study (e.g., locate and access information), there is also a recognition of the ways printed sources of information differ from those found on the Web. Locating and critically evaluating sources on the Web is an important task in research using the Web. This aspect of information problem solving was not examined in this study and consequently limits its scope.

Conclusion

Changing literacy practices calls for examination of instruction in how to access, locate, manage, and communicate information. In this instructional study, the students were guided in the search, selection, organization, and communication of their research performed on the Web. The primary goal of the study was to investigate how to support students' interaction with the Web for the purposes of writing reports on topics from social studies and science. The outcomes of the study were based on the quantitative analyses of students' written expository reports based on measures of writing quality, text length, and navigation. The control students improved in writing quality and navigation. The treatment students improved in writing quality, text length, and navigation, and significantly outperformed the control students on the measure of text length. Writing quality was measured on four traits: topic focus, organization, sentence length and variety, and the mechanics of language use. There were significant differences in posttest scores of the treatment group on three of these traits: topic focus, organization quality,

and sentence length and variety. There were significant differences in posttest scores of the control group on only two: topic focus and sentence length and variety.

The Big6 Skills seemed to keep students on track and served as a scaffold that may be successfully employed in a complex task of information processing and management. Using the Big6 Skills with the essay map resulted in reports that were longer and better organized than reports written by control group students who only were taught how to use an essay map.

Appendix A

Pre-intervention Session

Lesson Plan #1: Instruction in the task and search for information: WEATHER
(Twenty students, individually)

Date: _____
Student: _____
Beginning Time: _____
End time: _____

Objectives:1. Introduce the task.
2. Introduce the purpose of the task.
3. Explain the task.
4. Administer Likert motivation scale
5. Administer T/F questions
6. Present and explain the Web portal.

Materials: 1. Video camera.
2. Internet access.
3. Record sheets (T/F, navigation, Likert scale, Questionnaire).

Protocol to follow before instruction:

- ❑ Set the video camera.
- ❑ Check the Internet access.
- ❑ Check the computer connections.

Protocol to follow during instruction:

- ❑ Introduce the task
- ❑ Introduce the purpose
- ❑ Explain the task
- ❑ Introduction to the Web portal.
- ❑ The student takes notes in a Word document.
- ❑ TICA: Check off the skills on the TICA Check list.
- ❑ Navigation: record the number of links opened on the record sheet.
- ❑ Save the student work into his or her folder on the desktop after printing out two copies. One copy is placed into the student's folder and one into the instructor's folder.

1. Read the script.

Script:

"We will be working on the Science and Social Studies Fair. Our task is to search for information and write reports that will be placed on this poster [show the blank poster]. There are various topics here [point at the Web portal] and each topic has three links. You will explore the links and read information.

(a) Your task is to write a report for the Science and Social Studies Fair to be shared with fourth graders here at your school so they can learn topics covered in higher grades.
(b) Click on the page [topic: Weather] Explore the links to find information about rain, thunderstorms, and lightening.
(c) Open a Word document and take notes. Write down some important ideas and some details. You may also include some images, if you wish.
(d) Copy the URL (the Web addresses) where you found information for references at the end.
(e) When your report is completed, read over it and try to rephrase your sentences so that fourth graders can understand them."

2. Administer Likert motivation scale

_____Before we look at the Web portal with Web pages, I am interested in how much you are interested in the topics we will research. So, I will read some statements to you and I want you to tell me if you agree or disagree (administer the Likert motivation scale).

3. Administer T/F questions.

_____Our topic today is weather. Let's see how much you already know about weather. I will read five statements and you tell me whether they are true or false:

Here are the questions. Listen carefully:

(1) Rain forms from water vapor in the air. T/F
(2) We can see water vapor in the air. T/F
(3) Thunderstorm with lightening is dangerous. T/F
(4) Lightening in itself is not dangerous. T/F
(5) Lightening is gas. T/F

4. Save the student's work. Print out two copies.

Appendix B

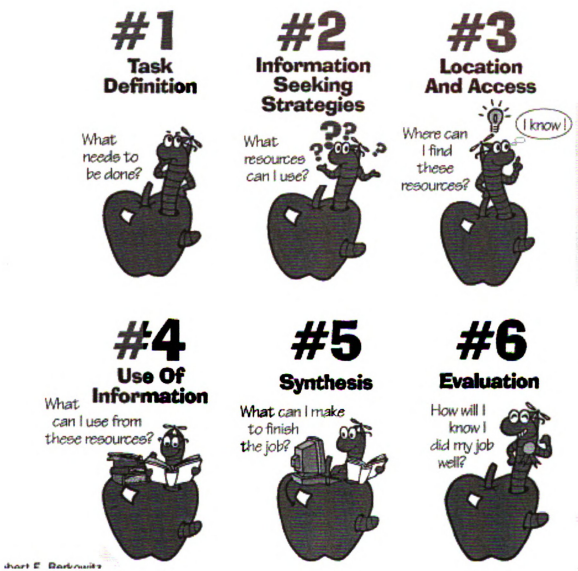
TICA Checklist

	Computer Basics
q	Turn a computer on/off
q	Use the mouse/track pad
q	Follow classroom and school rules for computer use
q	Open programs and files using icons and/or the Start Menu (PC)
q	Log on and log off from individual file space
q	Create/open a new folder/file
q	Launch a word processor
q	Open a word processing file
q	Type a short entry in a word processing file
q	Copy text
q	Cut text
q	Paste text
q	Delete text
q	Name a word processing file and save it
q	Open a new window
q	Open a new tab
	Web Searching Basics
q	Locate and open a search engine
q	Type key words in the correct location of a search engine
q	Type addresses in the address window
q	Use the refresh button
q	Use the "BACK" and "FORWARD" buttons
q	Use a search engine for simple key word searches
	General Navigation Basics
q	Maximize/minimize windows
q	Open and quit applications
q	Toggle between windows

(Source: http://www.newliteracies.uconn.edu/iesproject/documents/TICA_Basic_Skills_Checklist.do)

Appendix C

Handout 1–Big6 Skills The "Big6™" is copyright © (1987) Michael B. Eisenberg and Robert E. Berkowitz.



Appendix D

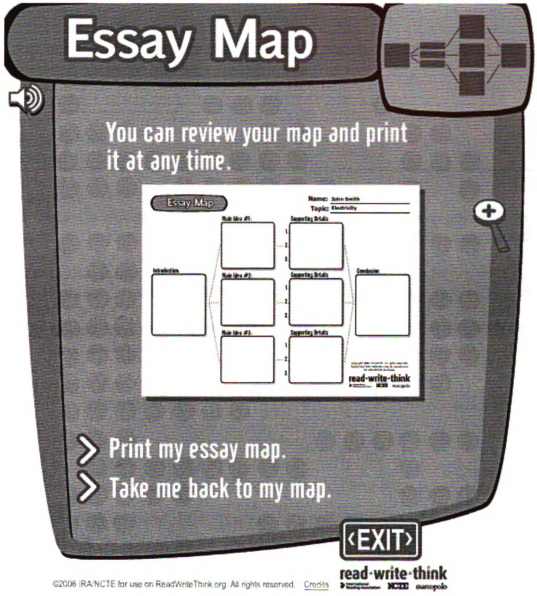
Script

"We will be working on the Science and Social Studies Fair. Our task is to search for information and write reports that will be placed on this poster [show the blank poster]. There are various topics here [point at the Web portal] and each topic has three links. You will explore the links and read information.

(f) Your task is to write a report for the Science and Social Studies Fair to be shared with fourth graders here at your school so they can learn topics covered in higher grades.
(g) Click on the page [topic: Weather] Explore the links to find information about rain, thunderstorms, and lightening.
(h) Open a Word document and take notes. Write down some important ideas and some details. You may also include some images, if you wish.
(i) Copy the URL (the Web addresses) where you found information for references at the end.
(j) When your report is completed, read over it and try to rephrase your sentences so that fourth graders can understand them."

Appendix E

The Essay Map Graphic Organizer



Source: Copyright © 2006 IRA/NCTE.

Appendix F

Intervention

Lesson plan #2:

Modeling Instruction: Curriculum elements of information problem solving with questions to guide the process.

Date: _____
Student: _____
Beginning Time: _____
End time: _____

Objectives:
1. A student is introduced to the first four steps of the Big6 research process. I go over the handout of The Big6 Skills Curriculum adopted from The "Big6™" - copyright © (1987) Michael B. Eisenberg and Robert E. Berkowitz (Appendix C).
2. The student is introduced to the Essay map handout (Appendix E).
3. The instructor models the first four steps of the information-problem solving with Big6 Skills.
4. The student completes information problem solving on his or her own with the first four steps in the Big6 Skills.

Materials: 1. Video camera.
2. Internet access.
3. Computer connection.
4. Likert scale motivation sheet.
5. Topic T/F questions.
6. Navigation score sheet.

Protocol to follow before instruction:
- ❑ Check the video.
- ❑ Check the Internet access.
- ❑ T/F questions
- ❑ Likert scale motivation sheet.
- ❑ Navigation score sheet.
- ❑ Questionnaire

Protocol to follow during instruction:

- ❑ Instructor models task definition.
- ❑ Instructor models information-searching strategies.
- ❑ Instructor models information location and access.
- ❑ Instructor models use of information.

Appendix G

Intervention: Modeling Steps 5 and 6 of the Big6 Skills

Lesson plan #3:

Modeling Instruction: Curriculum elements of information problem solving with questions to guide the process (Synthesis and Evaluation: steps 5 & 6 of the Big6 Skills).

Objective:
1. Model how to synthesize information.
2. Model how to evaluate the product.
3. Model how to evaluate the process.

Materials:
1. Internet access.
2. Web portal: Page Creator with Weather
3. Guiding questions: questions to guide the process and questions to evaluate the product.

Protocol to follow before instruction:

- ❑ Check the camera
- ❑ Check the Internet access.
- ❑ Open the Web portal
- ❑ Open the page Weather

Protocol to follow during instruction:

- ❑ Instructor models the synthesis of information.
- ❑ Instructor thinks aloud and shares the guiding points for information organization
- ❑ Instructor thinks aloud and shares the guiding questions.
- ❑ Instructor synthesizes information.
- ❑ Instructor models the evaluation of the product and the process.
- ❑ Instructor asks the student to evaluate the product and the process.

INSTRUCTION with modeling:

Step 5 of the Big6Skills: Synthesis: How will I organize my information?

Guiding points for organizing information:

- Introduction
- Main ideas
- Supporting/explaining details
- Consider illustrating main ideas or details with pictures
- Conclusion

(b) Guiding questions:

- Is my text understandable?
  Could even young readers understand what I wrote?
- What are some parts that need rewriting?
- Rewrite/paraphrase: if necessary, go back to the Web pages.
- Look back at your text: Are there any words that need to be explained or clarified?

Step 6 of the Big6 Skills: Evaluation:
_____I evaluate my product and process and the student does the same against the guiding questions:

b) Judge the product (effectiveness)
   - Did I do what was required?
   - Is the task completed?
   - Is my presentation going to be understood by my peers?
   - Will they be able to learn anything from it?

c) Now that I look at my product:
   - Is there anything I can do better the next time I conduct research?
   - Could I be more efficient in locating information?
   - Could I be more efficient in organizing information?
   - Could I be more efficient in creating my final piece?

_____Additional guiding questions (based on Jansen in Eisenberg & Berkowitz, 1999, pp. 120-121).

- Is my assignment complete according to the defined task?
- Did I give proper credit to my sources?
- How efficient was I at choosing and finding my information?
- What did I learn how to do that I can use again?
- How can I use the skills again?
- How well did I do on my project? (The student can give a rating or grade)
- What could I do better next time?

Appendix H

Motivation Scale

Instructor: *I am going to read you some statements and I want you to tell me if you agree or disagree. You can also agree a lot- like "strongly agree" which I will mark as 5, or disagree a lot- "strongly disagree", which I will mark with 1. WE will go over these as I ask the questions. The important thing is that you feel free to disagree – no one will see your answers but me.*

Motivation: Likert scale

___ ___ ___ ___ ___
(1) (2) (3) (4) (5)

1= Strongly disagree
2= Disagree
3= Unsure
4= Agree
5= Strongly agree

1. I am interested in reading and learning about <topic x >.

___ ___ ___ ___ ___
(1) (2) (3) (4) (5)

2. I am interested in doing research on the <topic X> on the Internet.

___ ___ ___ ___ ___
(1) (2) (3) (4) (5)

3. I am interested in learning about <topic x> from some other sources (e.g., teachers, parents, friends) rather than to read and research on my own (on the scale from 1 to 5)?

___ ___ ___ ___ ___
(1) (2) (3) (4) (5)

4. I would like to write about <topic X> for my fourth grade peers.

___ ___ ___ ___ ___
(1) (2) (3) (4) (5)

Appendix I

Topics and Web sites

Weather (rain, thunderstorms, lightening)

http://www.weatherwizkids.com/Rain.htm Flesch-Kincaid: 6.7

http://www.weatherwizkids.com/thunderstorm.htm Flesch-Kincaid 6.8

http://www.weatherwizkids.com/lightning1.htm Flesch-Kincaid 6.2

Three government branches: Big6–steps 1 through 4.

http://bensguide.gpo.gov/3-5/government/branches.html Flesch-Kincaid: 7.5

http://library.thinkquest.org/5873/the.htm Flesch-Kincaid: 7.2

http://www.evgschool.org/three_branches_of_government.htm Flesch-Kincaid: 7.2

Electricity

http://www.aecl.ca/kidszone/atomicenergy/electricity/index.asp Flesch-Kincaid:10.0

http://www.energyquest.ca.gov/story/chapter02.html Flesch-Kincaid: 7.4

http://www.miamisci.org/af/sln/frenkenstein/safety.html Interactive game

Constitution

http://www.usconstitution.net/constkidsK.html Flesch-Kincaid: 3.8

http://bensguide.gpo.gov/3-5/documents/constitution/index.html Flesch-Kincaid: 6.8

http://www.whitehouse.gov/kids/constitution/facts.html Images

(Click on ABC cards and view images and read some facts)

Presidents

http://www.earlyamerica.com/gwlifemovie2.htm (Part I: 10 minute movie about the life of George Washington)

http://www.americaslibrary.gov/cgibin/page.cgi/aa/presidents/jefferson Flesch-Kincaid:10.3

http://www.americaslibrary.gov/cgibin/page.cgi/aa/presidents/lincoln Flesch-Kincaid:7.7

Electricity and safety

http://www.epcor.ca/elec_safety_world/hurt/travel_through.html Flesch-Kincaid: 8.9

http://www.safeelectricity.org/esw_v1_1/safe_choice/index.html Interactive quiz: 6 questions about safe choices (2 points each: 1-5 "Good job"; 6-9 "Great job", 10-12 "Outstanding job").

http://www.rp-l.com/electricsafety.htm Flesch-Kincaid: 7.3

Magnets and magnetism

http://home.interserv.com/%7Eskyblade/wim.htm Flesch-Kincaid: 5.7

http://home.interserv.com/%7Eskyblade/charges.htm Flesch-Kincaid: 5.2

http://home.interserv.com/%7Eskyblade/compass.htm Flesch-Kincaid: 4.8

Electrical past and present

http://www.southerncompany.com/learningpower/timemachine.asp Time machine (Click on the year)

http://www.southerncompany.com/learningpower/howplants.asp Interactive site (How plants work)

http://www.southerncompany.com/learningpower/energyuse.asp Interactive site (Click on the appliances to see how much electricity they use)

Circuits

http://www.thetech.org/exhibits/online/topics/1xb_flash.html Flesch-Kincaid: 8.9

http://www.thetech.org/exhibits/online/topics/12i_flash.html Flesch-Kincaid: 8.8

http://www.thetech.org/exhibits/online/topics/12h_flash.html Flesch-Kincaid: 9.1

Electrical past and present

http://www.southerncompany.com/learningpower/timemachine.asp Time machine

(Click on the year)

http://www.southerncompany.com/learningpower/howplants.asp Interactive site

(How plants work)

http://www.southerncompany.com/learningpower/energyuse.asp Interactive site

(Click on the appliances to see how much electricity they use)

Symbols of the government

http://bensguide.gpo.gov/3-5/symbols/eagle.html Flesch-Kincaid: 9.2

http://bensguide.gpo.gov/3-5/symbols/flag.html Flesch-Kincaid: statistics not reliable

http://bensguide.gpo.gov/k-2/symbols/ladyliberty.html Flesch-Kincaid:7.2

Conductors and insulators

http://www.epcor.ca/elec_safety_world/travels/conductors.html Flesch-Kincaid: 9.1

http://www.bbc.co.uk/schools/ks2bitesize/science/activities/conductors.shtml Interactive

(Online Experiments)

http://www.epcor.ca/elec_safety_world/travels/insulators.html Flesch-Kincaid:10.4

Tornadoes

http://eo.ucar.edu/webweather/tornado2.html Flesch-Kincaid: 6.9.

http://kids.nationalgeographic.com/Games/PuzzlesQuizzes/Brainteasertornado

(Games/Quizzes)

http://www.spc.noaa.gov/faq/tornado/ Flesch-Kincaid: 10.9.

Appendix J

Semi-structured Questionnaire

1. How would you evaluate your work? Do you think you did what was required (remember the task definition)? Tell me something about the work you created for the Fair posters.

_____

_____

2. Do you think you learned some skill(s) this time that you could use again? Questions to consider:

- What did I learn how to do that I can use again?

  How can I use the skills again?

_____

_____

3. What do you think you did well this time? (Do you think you selected some important information? Do you think your peers will understand your piece?).

_____

4. Why do you think so?

_____

_____

5. Would you do anything differently next time?

Question to consider:

- What could I do better next time?

- What would I do differently next time related to the search for information?
- What would I do differently related to the product (a Fair piece)?

_____

_____

6. Do you think the steps in the Big6 are useful?

Yes/No.

- Why yes? (Or why not?)

_____

_____

Appendix K

True/False Prior Knowledge Questions for Each Topic

Weather

There is always water vapor in the air.
Thunderstorms usually occur in the early mornings.
Lightning and thunderstorms may sound terrible but are not dangerous.
Thunderstorms usually happen in a dry climate.
Water droplets form from cold air.

Branches of the government

The three government branches are three ways to govern the Supreme Court.
Three government branches separate the Founding Fathers of the country from the Constitution.
The three government branches are the Congress, President and Vice President, and the Supreme Court.
The three government branches are more powerful than the Constitution.
The three government branches regulate the Constitution of the United States.

Electricity

Electricity is a form of natural gas.
Electricity is a form of crude oil.
Electricity consists of insulators and conductors.
Electricity is something we can always see in the dark.
Electricity is a form of energy.

Constitution

The Constitution regulates the Founding Fathers of America.
The Constitution vetos the laws and bills passed in the U. S. Congress.
The Constitution is the document which establishes the basic principles of the U.S. government.
The Constitution is a statement made by the President of the United States.
The Constitution is a form of government.

Conductors and Insulators

Electricity flows through any kind of material easily.
A conductor is material that electricity can flow through easily.
An insulator is a material that attracts electricity.

Water is not a good conductor.
Metal is not a good conductor.
Presidents

The second president of the US was Benjamin Franklin
The first president of the US was Abraham Lincoln.
The first president of the US was Thomas Jefferson.
The first president of the US was George Washington.
The second president of the US was Theodore Roosevelt.

Electrical Safety

Electricity flows through water easily.
Electricity does not flow through water, only through electrical wires.
Electricity cannot flow through your body.
Electricity can flow through your body but will not hurt you.
Electricity cannot kill you.

The Bill of Rights

The Bill of Rights is a short document that describes the House of Representatives and the Senate.
The Bill of Rights are the first ten amendments to the Constitution.
The Bill of Rights states what the President of the United States has to do in the government.
The Bill of Rights is meant to limit some rights stated in the Constitution.

Electrical Past and present

Electricity is everywhere so there is no need to worry about conservation.
TV does not use electricity.
We can turn a light off and save energy.
Energy is not renewable.
All energy is renewable.

Magnets

Two negative magnets attract.
Two positive magnets attract.
The Earth pulls positively charged things like protons toward the North pole.
The Earth and the Sun are magnetic.
The Earth pulls negatively charged things like electrons toward the South pole.

Symbols of the government

There is only one symbol of the government: the golden eagle.

There is only one symbol of the government: the flag of the Unite States.
There is only one symbol of the government: the Statue of Liberty.
There are many symbols of the government but people have different opinions about which are the true symbols.
There are several symbols of the government and the bald eagle is one of them.

Circuits

Electricity does not travel along a path called a circuit.
Electricity never follows a path because it does not know when we will switch the light on.
When we turn on the light, the electrons are steady and do not move.
We may have a series of circuits, like batteries in a flashlight.
We cannot turn on two lights at the same time.

Tornadoes

Tornadoes are caused by heavy rains.
Scientists know everything we need to know about tornadoes.
A tornado is a rotating column of air.
Tornadoes are caused by blizzards.
Tornadoes occur everywhere in the world equally.

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