USE OF STRATEGIES
FOR THE COMPREHENSION AND RETENTION OF
NONFICTION TEXT IN COMPUTER ENVIRONMENTS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By
Theresa Ann Holleran, M.S.

The Ohio State University
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Dissertation Committee:
Professor Suzanne Damarin, Advisor
Professor Anita Woolfolk Hoy
Professor Linda Condron
Professor Michael Browne

Approved by

Advisor
College of Education
ABSTRACT

Learners use various strategies to read and process nonfiction text. This study explored the use of underlining, highlighting, and taking notes within the text in both paper and computer environments. This research was specifically interested in whether the use of the strategies and medium affected student comprehension and retention; whether there were significant differences with respect to class, gender, and self-reported computer use on the student’s comprehension and retention; and whether there was a relationship between a participant’s self-reported computer ability, perceived control, and computer awareness with the use of online strategies.

The participants for this study were 152 undergraduate students attending a small liberal arts college in the Midwest. Participants were solicited from regularly scheduled courses, consisted of 48 males and 104 females, represented a variety of majors, and ranged in age from 17 to 60.

A quasi-experimental, within-subjects design was used with eight classes randomly assigned to one of four groups. All participants received the same initial set of directions, and were asked to read the same text and respond to the same sequence of online tasks. There were two between-subjects variables for this study: strategy use and medium. Participants were either given instruction on the use of strategies in the
processing of nonfiction text and the encouragement to use such strategies while reading
the text, or given neither additional instructions nor mention of the use of strategies.
Participants read the text either on the computer screen or on paper. Time (pretest,
posttest1, posttest2) was the within-subjects variable.
Participants who used strategies performed better than those who did not use
strategies. Participants who read the text on paper performed better than those who read
from the computer screen. On the comprehension measure, medium was significant for
those who used strategies. On the retention measure, use of strategies made no significant
difference, regardless of the medium. There were no significant effects for class, gender,
or computer use on comprehension and for retention, there was a significant effect for
computer use for senior females and junior males. Results found no significant
correlation between the computer variables and comprehension or retention.
Dedicated to Louis and Brucille
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VITA

December 17, 1952 ……………………Born – Columbus, Ohio

1986………………………………….. M.S. Computer Science,
Bowling Green State University

1986 – present………………………. Faculty,
Mathematics and Information Sciences
Ohio Dominican University

Mathematics, Physical Education

PUBLICATIONS


FIELD OF STUDY

Major Field : Education
Specialization: Technologies of Instruction and Media
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CHAPTER 1

INTRODUCTION

Learners of all ages use various strategies to process and comprehend the content presented in textbooks and other written formats. Reading specialists advocate the use of several strategies: making connections, questioning, visualizing, making inferences, determining importance, and synthesizing information (Harvey & Goudvis, 2000) to accomplish this task. Educators know that such strategies are effective in increasing the learner’s comprehension of the material (Harris & Graham, 1996) and, in some cases, even make learning possible for students who would otherwise be overwhelmed when presented with the need to sift through and make sense of ever-increasing amounts of information (van Oostendorp, 1996).

Computers, which are prevalent in today’s educational environments (Frear & Hirschbuhl, 1999), often serve as the medium for this influx of information and, as such, need to be considered in the discussion of how to process and comprehend what is read. Do learners use similar strategies to process information when that information is presented via the computer? Certainly, computer technologies and the environments they support (i.e., multimedia, hypermedia, Web) can help motivate the learner to learn, increase the learner’s control over the material being presented, and allow the learner to
take an active role in the learning process (Becker, 2000). However, when asked to read and process text on the computer, learners of all ages commonly print the text then read and process the text on the printed page. Why? Simply put, current computer environments do not encourage or facilitate the use of the same strategies that learners have come to use and depend on to process the printed page.

Those strategies for determining importance, such as underlining, highlighting, and making notes in the text or margins (Harvey & Goudvis, 2000), that the learner utilizes when working with printed text are not accessible once that text is moved to the computer. Learners simply cannot interact with the text in the same way that they would if it were in print, because once a section of text is digitized and locked (e.g., an html file) for the computer, it is static and thus, not able to be edited. One of the major advantages to current computer environments is the nonlinear, dynamic flow of information, but what strategies does the learner have at his/her disposal for the reading and processing of this information? What strategies allow the user to benefit from, and not suffer from, these computer environments?

Indeed, it may be that the known strategies used to process and comprehend text on paper are quite different from the strategies necessary to engage text on the computer screen (Murphy & Holleran, in press). This point is strongly supported by the technology (e.g., Lawless & Kulikowich, 1996; Olgren, 2000) and educational psychology (Alexander, in press) literature, but since our knowledge and understanding of these potentially new online strategies is only in its infancy, additional research is needed. Prior to this venture, I believe that it is important to look at the current on-paper strategies and
transfer them, if possible, to computer environments or as Olgren (2000) suggests, to link learning strategies to current learning technologies.

To that end, the goal of this research was to take a subset of known learning strategies (i.e., determining importance: underlining, highlighting, and writing notes within the text or margins) that have been utilized to support the reading of printed text and impose them on the reading and processing of online text. I use the word impose to emphasize the fact that these strategies are neither natural nor nicely facilitated by the use of the computer. The measures used in this research were presented to participants as a sequence of linearly linked html documents; that is, participants had no decision as to the order in which measures were presented. Since html documents are static, the text that participants were asked to read and process was presented as a Word document. This document was presented to one fourth (¼) of the participants on the computer screen with the Track Changes feature of Microsoft Word enabled. This feature allowed the reader to use the determining importance strategies of underlining, highlighting, and writing notes within the text; thus, allowing the reader to process the text as if it were on paper. This research encompasses a relatively small subset of the strategies that are known and available to readers of text, but it is a manageable subset in which to launch the discussion.

Research Questions

This study explored the use of a subset of comprehension strategies (i.e., determining importance: underlining, highlighting, and annotating) in both paper and computer environments. The following questions guided this study:
• To what extent does the use of the selected strategies (i.e., underlining, highlighting, and writing notes within the text) and medium (i.e., computer and paper) affect student comprehension and retention?

• Are there significant differences with respect to class (i.e., freshman, sophomore, junior, senior), gender, and self-reported computer use on the student’s comprehension and retention?

• To what extent does a participant’s self-reported computer ability, perceived control, and computer awareness play a role in using online strategies?
CHAPTER 2

REVIEW OF LITERATURE

This review examines the academic context in which to explore the relationship between the use of strategies in the processing of nonfiction text and the computer technologies that are found in today’s classrooms. To accomplish this task this review is divided into five sections. The first section offers a walk through part of the historical role of computer technologies in education and their affect on how students learn. The second section examines those aspects and concepts of learning that are pertinent to the topic. The third part introduces the concepts and terminology of strategies, especially in application to the reading and comprehension of text. The fourth section describes a selection of those characteristics belonging to either the learner or the text that typically affect the learner’s interaction with the text. The last section clarifies those questions that arise from the reviewed research: concepts and opinions of the experts in the fields of computer technologies, learning, and the use of strategies in educational settings that directly shape the way students learn through the processing of text in computer environments.
Computer Technologies

Numerous technologies have appeared on the educational scene in the past, but none rival the potential of the microcomputer as an effective educational tool. Thoughts of computer-assisted learning (CAL) and computer-managed learning (CML) once filled the air with expectations that the computer, indeed, could be used to improve learning. In the early 1960s, programmers at Stanford University and the University of Illinois began adapting lessons for presentation by computer (Hackbarth, 1996). From these early projects it was presumed that students could learn basic subject matter just as well from a computer as from books, films, or teachers. The computer, in principle, has many advantages over other media in the educational environment—provision of immediate feedback, presentation with animation and sound, active interaction, and individualization (Yang & Chin, 1996-97). These advantages, in effect, might even be more likely to motivate students to learn via the computer than from any other media (Bagui, 1998). This section, therefore, explores the question of whether, and to what extent, the computer has affected what transpires in the classroom with respect to learning.

Technology Availability

The mere availability of computers in today’s educational environment might be seen as an asset to learning. Dwyer (1994) reports on the Apple Classroom of Tomorrow project where high school students had constant access to computers. Test scores indicated that students were doing as well or better than they might without the technology. Students in this project routinely employed inquiry skills, collaborative skills, technological skills, and problem-solving skills.
Dugdale, LeGare, Matthews, and Ju (1998) report on a study involving thirty-two elementary and secondary teachers taking part in a summer institute of the Northern California Mathematics Project. Computers were readily available to the participants, although the instructors for the institute neither modeled nor made any suggestion that the computer might be used in the solution to problems. Problems were chosen for their math characteristics, not for their computer fitness; that is, each problem could be solved without a computer. Since the computer was available, participants were on their own in deciding whether, when, and how to use it. Participants worked in groups during the problem solving sessions. Researchers found that every group attempted to use the computer at some point during the session and, for the most part, the spontaneous use of the computer was an asset to solving the assigned problems.

The mere presence of computers in the classroom guarantees nothing (Mellon, 1999; Wetzel, 1999); in fact, sometimes the computer interferes with learning. Both Dwyer (1994) and Dugdale et al. (1998) reported that at times the use of the computer impeded learning to the extent that participants wasted valuable time attempting to fit the computer to the assigned task—the solution was easier and more direct without the computer. Mellon (1999) suggests, as have many before her, that the computer is simply one of the tools for learning and, in many circumstances, not necessarily the best tool.

**Programming**

Early researchers of computer use yearned for a new tool to enhance learning. Papert (1980) thought that computers could be “carriers of powerful ideas and seeds of cultural change” (p. 4) by helping people form new relationships with knowledge. He
introduced the Logo programming language to children and claimed that by learning to use the language the student would learn some mathematical ideas, some programming ideas, and, most importantly, develop some thinking skills (Hackbarth, 1996).

Kurland, Pea, Clement, & Mawby (1986) also sought a connection with the study of programming to math ability, problem-solving techniques, and higher-level thinking skills. They believed that computer programming could be a powerful means of enhancing these skills in high school students. Their year-long study used three groups: students enrolled in the second year of programming; students who had one year of programming instruction, but chose not to continue to the second year; and students with absolutely no programming experience. The goals of the study were to show the impact of programming on math and reasoning abilities, to show the impact of math and reasoning skills on programming, and to observe the kind of programming knowledge attained. According to the results, most students gained only a modest understanding of programming. When asked to create their own programs they typically used a trial-and-error approach and immediately asked for help when something was not obvious. Additionally, there was seemingly no relation between the effect of programming on math or reasoning skills. It also seemed that very few of the students in this study acquired high-level thinking skills or increased their ability in the programming language.

Kurland et al. (1986) attributed this trial-and-error approach to a lack of appropriate techniques or rules for systematically analyzing programs and developing corrections (i.e., debugging). Results of Papert’s early work also indicate that students generally approached the Logo programming tasks with a trial-and-error method rather
than “as designers who plan and debug their own work” (CTGV, 1996, p. 823). From these early works it became obvious that the teaching of programming, by itself, was not the new tool to enhance learning it was once thought to be.

*Simulation*

Simulation has long been used to teach people to do things like fly an airplane, put out a fire, and drive a car. Simulation has been particularly appealing for situations where physical safety is an issue (Brown, 1999), but is also appropriate in situations where proper decision making is a goal. Computer games that might be classified as simulations (e.g., Doom, Quake, 7th Guest) tend to invite the player to be part of the environment and the game seems to respond to the player. Graphics, having improved to the point where they almost resemble movies rather than rough jagged video screens of past games can, perhaps, present great potential as a unique learning environment.

In a study performed by Pillay, Brownlee, and Wilss (1999) twenty-one high school students were observed while playing the computer game *Pilot Wing*. Researchers found that "players exhibit[ed] complex cognitive processes similar to those found in other problem-solving situations that use technology-driven systems" (p. 213). This study suggests that recreational computer games may have a role in educational environments, since they seemed to enhance cognitive skills (i.e., reading explicit and implicit information, reasoning inductively and deductively, making inferences from information displayed across a number of screens, reasoning metacognitively, and problem solving) in the players.
Brown (1999) suggests that simulation might even be used to augment the field experience of preservice teachers, since preservice teachers are traditionally placed in an environment that may or may not be pedagogically sound and thus, the “preservice teacher may adopt the habits and methods of the inservice teacher without fully evaluating their merit” (Brown, 1999, p. 307). Brown suggests that simulation might provide a more natural environment in which to test out decisions and consequently, experiment with the role of teacher before entering the real classroom.

Frear and Hirschbuhl (1999) used simulation to examine its effect on students’ grades and problem solving skills in undergraduate environmental science. Compared to the traditional lecture method of instruction the interactive multimedia simulations promoted participation and interaction, as well as a significant increase in both achievement and problem solving skills for those learning via the computer simulation method.

Simulation via the computer has been used in the classroom for a variety of activities: to relive the voyages of the early explorers crossing the Atlantic, to redesign our planet and its inhabitants, to provide laboratory-style dissection and experimentation, to teach a beginning driver to maneuver heavy traffic (Hack Barth, 1996); but, is simulation the primary answer to enhanced learning via the use of the computer? Simulation seems to fit in some environments and for some situations, but is it a sufficient and appropriate tool for learning in all environments?
**Multimedia**

The 1990s brought us the concepts of multimedia, hypermedia, and the World Wide Web. Each of these new learning environments brought a hope for enhancing the learning process. Multimedia is the use of text, graphics, animation, pictures, video, and sound to present information (Bagui, 1998). When learners use multimedia they are accessing the material in more than one format simultaneously.

Studies have shown that when compared to the traditional classroom lecture environment, computer-based multimedia can assist students in learning more information, more quickly (Bagui, 1998). Bagui asserts that this increase in learning with multimedia comes about because of the parallels between multimedia and the natural way people learn. Proponents of this dual coding theory believe that all information is processed through one of two commonly independent channels. One channel will process verbal information, such as text and audio; whereas, the other channel will process all nonverbal images, such as graphics and sound. Thus, dual processing is thought to generate an enhanced effect because the learner has created more cognitive paths that can be followed to retrieve information (Bagui, 1998).

Studies performed by Mayer (1999) found that college students unfamiliar with a topic “are better able to make sense of a scientific or mathematical explanation when they are able to hold relevant visual and verbal representation in working memory at the same time” (p. 621-622). In fact, from this research, Mayer concluded that well-designed multimedia presentations could even help students understand material in ways that lead to problem-solving in other domains. Hartley (1999) agreed that a multimedia approach
with text and graphics can play a role in effective instruction, but only if the graphics convey pertinent, though different information than the text; for, irrelevant material only serves as a distraction to the learner and redundant information tends to hinder understanding altogether.

**Hypermedia**

Hypermedia is a computer-based system that tends to be nonlinear in structure and allows interactive linking of information in multiple formats including text, still or animated graphics, movie segments, video, and audio (Bagui, 1998; Hackbarth, 1996). The nonlinear characteristic of hypermedia introduces a new concept in the study of computers and computer software; namely, it can provide an increase in the learner's control over the subject matter and how it is approached, thus employing an element that is advantageous to students (Liao, 1998).

A meta-analysis performed by Liao (1998) compared the effects of traditional instruction with hypermedia instruction in thirty-five studies resulted in some interesting findings. Twenty-four of the studies reported significant gains in favor of hypermedia instruction, while ten of the studies favored the traditional instruction. Only one study found no significant difference between the two methods of instruction. According to Liao’s analysis, hypermedia instruction had only moderately positive effects on students' achievement over traditional instruction.

**The World Wide Web**

The World Wide Web provides information that is instantly available, often very current, worldwide in scope, and presented in an acceptable and motivating format for
learning (Owsten, 1997). Travels on the Web can result in attractive, vivid, and engaging presentations. The hyperlinking capabilities of the Web naturally provide entirely new ways of presenting information in a nonlinear, dynamic form. Ideas can be presented in a manner more closely resembling the way in which we think, without adherence to a specific order (Bonime & Pohlmann, 1998). In addition, links can be established between any two existing Web sites. The reader can then navigate freely from one site to another by simply clicking on the highlighted and/or underlined indicators of existing links (Romiszowski, 1997). These links have the potential to lead one to a myriad array of information in text, graphical, audio, and video form. The World Wide Web has the potential for connecting all of the world's electronically stored information. The reader thus has the ability to browse through additional sites to acquire information on any subject at any time (Jonassen, Dyer, Peters, Robinson, Harvey, King, & Loughner, 1997).

Skarecki & Insinnia (1999) report on the use of the Web in their eighth grade language arts class. The Web dramatically changed the approach to teaching and learning in the classroom according to both students and teachers. Students remembered information that they found on the Web, used higher level thinking skills in acquiring the information, spoke knowledgeably and impressively about the information found, and were able to draw conclusions about the information on their own. Students took an active role in their own learning. Traditional methods (e.g., handouts) of presenting information were meaningless to many of the students once the Web was introduced.
Learning

The primary motivation for using computer technologies in education is the belief that they will support learning, even higher forms of learning (Lieberman & Linn, 1991; Means, Blando, Olson, Middleton, Morocco, Remz, & Zorfass, 1993). Resnick (1987b) suggests that some of the key features of higher-order skills would include the advanced skills of comprehension, reasoning, composition, and experimentation. There are a number of theories that are commonly used to explain how these skills are acquired; that is, how learning occurs. It is not my intent to cover these theories in depth, but to touch on those aspects that are pertinent to the use of computers in the learning process.

Becker (2000) believes that “teachers whose objectives for having students use computers are consistent with a constructivist view of learning” (p. 7). A major theme in the constructivist framework is that learning is an active process in which learners construct new knowledge based upon a blending of their previous knowledge and experiences with the new knowledge (Ewing, Dowling, & Coutts, 1998; Graves, 1998; Kurland et al., 1986). The learner is a constructor of meaning (Resnick, 1987b) and the skills of comprehension, reasoning, composition, and experimentation are acquired mainly through the learner's interaction with content rather than through the transmission of facts (Collins, Brown, & Newman, 1989; CTGV, 1996; Isernhagen, 1999; Means et al., 1993; Resnick, 1987b). This view of cognition calls for “teaching basic skills within authentic contexts, for modeling expert thought processes, and for providing for collaboration and external supports to permit students to achieve intellectual accomplishments they could not do on their own” (Means et al., 1993, p. 2).
According to Resnick (1987b), education does not adequately engage such meaning-construction capabilities in students. Schools should enable students to search for information, process it, and create their own knowledge. In order to do this students must engage in dynamic situations that require them to think critically, solve problems, and search for answers to their own questions (Oughton & Reed, 1998); that is, students must learn to learn (Bazillion & Braun, 1998; Brown, Campione, & Day, 1981).

Bagui (1998) talks about a discovery-based approach to learning, which often leads to an increase in student involvement and thus, greater understanding. Means et al. (1993) address the concept of collaborative learning where the role of the teacher becomes one of facilitator rather than that of dispenser of knowledge. Bazillion and Braun (1998) suggest that active learning, individualization, cooperative learning, critical thinking, and contextual learning might produce excellent results at developing the necessary skills that students need to acquire.

Regardless of the desired tool or medium, one of the key factors to learning seems to be the learner’s level of engagement with the content to be learned; hence, one of the key questions is whether current computer technologies can facilitate such engagement. As stated previously, computer technologies can allow, even help, the learner to take an active, engaged role in the learning process (Becker, 2000). Current computer-based systems may contribute to the enhancement of learning simply because of their ability to represent subject matter content from different views, in different contexts, and by means of different symbol systems (Tergan, 1997). In fact, the sheer newness of such computerized lessons may be enough to engage the learner and, thus, enhance learning
for a while, until the newness fades. It is also, of course, a reality that some of these lessons just do not engage the learner in active processing and restructuring of information at all (CTGV, 1996). Traditional lessons are often merely transformed into digital form and presented in the same order, with the content and illustrations unaffected. Learners are expected to gain understanding while reading through the content in much the same way that they would if it presented in a typical textbook or handout. If this is the case, then learners need to approach the comprehension of such textual content in much the same way that they would approach the task of learning from traditional text-based material. That is, when attempting to learn from computer-based textual content, learners need to use the same strategies that they use to process and comprehend text-based content. In other words, the learner must engage in the process of learning from the text, regardless of the medium.

Learning Strategies

Research has shown that readers pay more attention and therefore, comprehend better, when they use learned strategies to process the text being read and studied (Harvey & Goudvis, 2000; Weinstein & Mayer, 1986). The purpose of this section is to define and classify the type of learning strategies that are typically used in the reading and processing of text and then to delineate the subset of strategies that are focused on in this study. Brown, Bransford, Ferrara, and Campione, (1983) define strategies as plans, routines, or activities deliberately called into use in remembering, learning, or problem solving situations. I am using the word strategy in this manner. Others have made a distinction between the plan of approach and the actual activities used to implement the
plan; for example, Woolfolk (1995) would use the word *strategy* to talk about the overall plan of attack and *tactics* as the techniques used to carry out the plan. Still others, for example, Weinstein and Mayer (1986) equate the terms *technique* and *strategy*. While Armbruster, Echols, and Brown (1982) emphasize the distinction between a *technique* and a *strategy* when they say, “students can use a technique ‘blindly,’ that is, without using it strategically in processing text information. A technique becomes a strategy only if students have the (metacognitive) knowledge of when, where, and how to use it” (p. 52). In this sense, a technique is most likely something that has been routinized—an automatic procedure. When a learner’s routine or typical approaches are not enough to resolve a given situation, then conscious, intentional, and effortful processing is necessary—the learner consults their collection of strategies (Alexander, Graham, & Harris, 1998).

Regardless of the term(s) used, most reading comprehension researchers would include the following, perhaps with a different label and/or order, in the list of those strategies to be taught: making connections, questioning, visualizing, making inferences, determining importance, and synthesizing information (Brown, 1975; Dole, Duffy, Roehler, & Pearson, 1991; Harvey & Goudvis, 2000). The making connections strategy is that which enables the reader to connect their prior knowledge and experience with the text being read. Questioning is the strategy that is intended to keep the reader engaged with the text. Questioning such things as what is read, what is the meaning, and how everything fits together enables the reader to move forward in the text; thus, to make meaning of the text. Creating a visual image of the text is a strategy used to enhance
understanding of the content. The reader is expected to visualize the images and feelings presented in the text in an attempt to make the words more real for him or her. The making inferences strategy relates to the concepts of making judgments, recognizing a theme, and speculating about what is to come in the text. Inferring occurs when the reader’s prior knowledge and questions merge with clues from the text to point toward a conclusion about an underlying theme or idea in the text (Harvey & Goudvis, 2000). The strategy of determining importance helps the reader separate the important from the less important ideas and information within the text—to pull out the meaning of the text. Synthesizing is the strategy that allows the reader to create a new thought or concept by mulling through and pulling together the important fragments of information presented in the text.

Strategies might pretty much be taught and, presumably become usable to the learner, in the order in which they were presented in the previous paragraph. Seemingly, there is an increase in the level of difficulty or sophistication as we move from making connections to synthesizing information (Pressley, Brokowski, & Schneider, 1987). Research has shown that poor readers frequently have trouble determining the important information in the text (Brown & Smiley, 1977) and rarely infer or synthesize (Anderson & Armbruster, 1982; Paris, Lipson, & Wixson, 1983), but might be relatively capable of making connections, questioning, or drawing a mental picture from the reading (Brown, 1980). Proficient readers, on the other hand, rarely use such strategies in isolation, but rather interact and intersect strategies to facilitate processing and comprehension of the text (Harvey & Goudvis, 2000).
All strategies can be used when reading and processing text, regardless of the genre, but the task of determining importance is perhaps most closely associated with the reading and processing of nonfiction text. After all, the student reader is ordinarily being asked to remember what is read for later recall on assignments, papers, tests, etc. when working with nonfiction text.

**Determining Importance Strategies**

Determining importance is not the easiest or the most important of all strategies; it simply tends to be the most frequently needed in the classroom situation where the text is primarily nonfiction. Most reading specialists would include underlining, highlighting, taking notes within or outside the text, skimming or scanning the text, reading the first and last sentences of each paragraph, outlining the text, and paying attention to text cues found in the margins as tasks that help in determining the important aspects of the text (Alvermann & Phelps, 2002; Harvey & Goudvis, 2000). The determining importance strategies are also some of the easiest strategies to measure or confirm that they have, in fact, occurred. For these reasons, the determining importance techniques of underlining, highlighting, and annotating were utilized in this research project.

*Underlining / Highlighting*

Underlining is one of the most popular learning strategies used by students (Park, 1995). Park defines underlining as the process of highlighting or drawing a line underneath the portions of text that are judged to be important while studying. The underlining or highlighting of important words, phrases, or sentences allows the reader to
process the text while reading, as well as refer to those underlined portions later, perhaps while studying for a test.

The literature on the effects of underlining is conflicting. Several researchers found a significant relationship between underlining and the recall of information (Cashen & Leicht, 1970; Hartley, Bartlett, & Branthwaite, 1980; Rickards & August, 1975). Yet, there are several studies that failed to find positive results from underlining. In a review of literature on the effectiveness of underlining, Hartley et al. (1980) analyzed 41 studies that compared an underlining condition with a control condition and found no strong evidence to indicate that underlining is more effective than other more passive methods, such as reading-only or repetitive reading.

**Annotating**

The process of annotating the text is the activity of making notes in the margins or within the text itself (Park, 1995). Annotating is an encoding function that requires the reader to process the information while reading. Annotating is primarily seen as a determining importance strategy, but may also incorporate aspects of other strategies as well, particularly, making connections, questioning, inferring, and synthesizing. Numerous studies have explored the aspects and efficient use of note taking while reading (Kiewra, 1985), but research on annotating within the text as a processing technique is scarce.

**Factors Affecting Learning**

There are undoubtedly characteristics of both the learner and the text that help and/or hinder the ability to engage, and thus, learn through the processing of information.
Certainly, computer technologies and the environments they support (i.e., multimedia, hypermedia, Web) can help motivate the learner to learn, increase the learner’s control over the material being presented, and allow the learner to engage in the learning process (Becker, 2000); but, both the learner and the material being presented come to this learning environment with characteristics that affect students’ ability to learn. This influence is worth examination. From the learner’s viewpoint, we would consider such variables as prior knowledge of the topic, the ability to use strategies in the process of learning, the motivation to process the information, interest in the text or topic, attention, effort, engagement, and one’s own metacognitive knowledge. From the vantage of the text we would include variables such as genre, length, and organization of the text, as well as, the medium through which the text is presented, in our investigation.

Learner Factors

Prior Knowledge

It is widely understood that learning involves the process of applying prior knowledge to new situations (Greeno, Collins, & Resnick, 1996). Studies show that the amount and type of prior knowledge that a learner brings to an environment affects learning (Kardash & Scholes, 1995). It is quite conceivable that the presence or absence of prior knowledge will affect the selection of principles, skills, and strategies that will be appropriate for approaching a learning task. Numerous studies show that when presented with a specific learning task, subjects will first search for analogous prior knowledge that could be of assistance to them in performing the task (Anderson, 1979; Clark & Voogel, 1985; Mayer, 1980); however, sometimes the use of prior knowledge can result in a
negative affect on learning. The search for analogous prior knowledge may result in the retrieval of irrelevant (Clark & Voogel, 1985) or inaccurate (Kardash & Scholes, 1995) information or strategies that can actually interfere with the acquisition of new knowledge. So it would seem that prior knowledge or strategies are of benefit only when they are relevant to the current task or situation.

According to McNamara and Scott (1999), the most influential factor in learning from texts is the reader’s prior domain knowledge since “students with more domain knowledge better understand difficult text material from that domain” (p. 387). When processing text, all readers combine their existing knowledge with a range of cues from the text to construct meaning from the text (Dole, Duffy, Roehler, & Pearson, 1991), but poor (or novice) readers have more difficulty accomplishing this task (Sullivan, 1978).

**Development and Use of Strategies**

As stated earlier, the comprehension and retention of information (i.e., learning) can be enhanced by the use of numerous strategies. As students we’ve learned to benefit from the use of strategies in constructing meaning from the information presented to us in written form. As such, the use of strategies affects how we learn, how we think, and how we motivate ourselves in order to learn from text (Olgren, 2000). Strategies are part of the knowledge base and, therefore, are presented here as a characteristic of the learner (Brown, Ash, Rutherford, Nakagawa, Gordon, & Campione, 1983). It is the learner who engages in the thinking and behaviors of strategy use to accomplish the intended goal of learning (Olgren, 2000). It is the learner who deliberately selects a particular strategy
from their cache of learned strategies and applies that strategy to attain the specific goal (Paris, Lipson, & Wixson, 1983).

Strategies are always being applied to some specific materials (Pressley, Borkowski, & Schneider, 1987; Rabinowitz, 1988), in some specific context. The goal is never the use of a strategy in itself, but rather an attempt to understand a text passage, to learn materials for later recall, to find the answer to a problem, etc. (Pressley, Borkowski, & Schneider, 1987). Sufficient prior knowledge, though, can eliminate the need for strategy activation. An expert in a domain hardly needs to rely on strategies to read and process text material in their domain; consequently, many instances of efficient learning occur without strategic assistance (Chi, Feltovich, & Glaser, 1981). The use of strategies is especially important during initial learning or when the task is so difficult that usual skills do not work (Paris, Lipson, & Wixson, 1983). One of the key components of the use of strategies is how a learner acquires and uses the knowledge of when, where, and why to apply various strategies (Brown, 1975).

Research shows that both novice and expert readers use strategies (Sullivan, 1978), but they use them differently. Novice readers frequently use an incorrect strategy or they use it in an inefficient or ineffective way (Alexander, Graham, & Harris, 1998) and thus, experience difficulties in reading and processing the information provided in the text (Pressley, Borkowski, & Schneider, 1987). In addition, novice readers often perceive all the information in a passage as equally important or equally bewildering. Good readers, on the other hand, are able to see the relative importance and interrelations of the various ideas presented in the text (Alvermann & Phelps, 2002) and are
consequently, able to draw from their broad repertoire of strategies to process the text with the correct strategies, in an efficient, effective manner—to determine the important from the unimportant. Expert readers typically use strategies to solve only those problems that are still novel or complex enough to warrant a strategic solution (Alexander, Graham, & Harris, 1998).

**Metacognition**

Someone who knows when, where, and how to use strategies has metacognitive knowledge (Brown, 1978). Metacognition refers to what a learner knows about their own learning process (diSessa, 1985) and is especially important because of how it affects the acquisition, comprehension, retention, and application of what is learned (Hartman, 1998). Proficient readers adapt strategies to their purposes for reading because they most likely have metacognitive knowledge—an awareness and understanding of how they think and use strategies during reading (Harvey & Goudvis, 2000). Most researchers talk about two separate, but related aspects of metacognition—the knowledge about cognition and the regulation of cognition (Brown, 1981; Flavell, 1987; Jacobs & Paris, 1987).

**Awareness.** Awareness, or knowledge about cognition, is the knowledge a learner has about themselves as learners, about their own cognitive resources, and about the learning task at hand (Puntambekar, 1995). This mindfulness (Salomon, 1979) is at the core of strategic behavior (Paris, Lipson, & Wixson, 1983). In other words, the use of strategies implies awareness (Dole, Duffy, Roehler, & Pearson, 1991). Good readers tend to be aware learners and, thus, are more strategic and perform better than poor readers (Garner & Alexander, 1989). In addition, good readers tend to reflect on what they are
doing while they are reading; that is, they combine existing and new knowledge with the flexible use of strategies to construct meaning (Dole, Duffy, Roehler, & Pearson, 1991; Harvey & Goudvis, 2000). Poor readers do not typically or spontaneously think about or assess their own performance while reading (Ringel & Springer, 1980)—they are tacit learners (Harvey & Goudvis, 2000).

Control. Control, or regulation of cognition, consists of applying active regulation skills such as goal setting; planning one’s next move; monitoring, evaluating, and modifying one’s plan (Puntambekar, 1995; Sternberg, 1998). Good readers know how, where, and why to use strategies and are thus in control of their own learning (Rabinowitz, 1988). This sense of conscious control (Dole, Duffy, Roehler, & Pearson, 1991) is the direct result of the metacognitive awareness that provides the reader with the ability to plan, sequence, and monitor their learning in a way that directly improves performance (Schraw & Dennison, 1994).

Effort / Engagement

Learning is the result of active mental engagement (Olgren, 2000). Such engagement involves the thoughtful awareness and use of various strategies. It would appear that some strategies require more demanding effort and, thus, incorporate a bigger commitment of time and mental resources than others (Alexander, Graham, & Harris, 1998). Hartley (2001) surmised that the reason “students often resisted the use of strategies was not because they were unaware of them, but because they lacked the necessary desire to implement such an effortful approach” (p. 291). Students who are engaged tend to approach challenging tasks eagerly and exert intense effort using active
comprehension strategies (Stipek, 1996). The decision to engage or not to engage the text is most likely made well before the student begins the task of reading (Anderson, 1979) and implies a certain level of motivation or interest on the student’s part.

**Motivation / Interest**

The reading and processing of text in order to remember is often motivated by grade, expectations of teacher or parent, or some other external stimulus. Students are often intrinsically motivated to read and process text from domains that they are interested in or in which they are proficient (Sternberg, 1998). Learning occurs when students are motivated to learn, regardless of where the motivation originates. A number of researchers have found a direct connection with motivation in students and the use of computers in the classroom (Becker, 2000; Olgren, 2000; Yang & Chin, 1996-97). Becker (2000) contends that computers provide an intellectual challenge, stimulate human curiosity, and provide a sense of independent control; thus, imparting a direct motivational impact on learning. Olgren (2000), on the other hand, surmised that students working at the computer may find it more difficult to remain motivated when there is less direct contact with an instructor or other students.

**Text Factors**

**Fiction / Nonfiction**

Often fiction tells a story, weaves a picture, or easily connects to a part of the reader’s experience (Harvey & Goudvis, 2000). Nonfiction, on the other hand, frequently presents the reader with an unfamiliar environment; that is, with limited prior knowledge (Alexander & Jetton, 1996). Without sufficient prior knowledge, readers are ill-equipped
to determine what is important in the text (Alexander, Kulikowich, & Schulze, 1994). In addition, when we read to learn new information, the texts tend to be more difficult to understand and therefore, more difficult to learn (Alexander & Jetton, 1996; Alvermann & Phelps, 2002; McNamara & Scott, 1999). Thus, the strategies that are commonly used in the processing of nonfiction text would conceivably be quite different than the strategies used to process fiction (Puntambekar, 1999).

Length

Common sense would have us consider an appropriate assumption that the longer the text, the more difficult the processing. About 80% of the reading a typical adult does on a regular basis would be considered short text: newspapers, magazines, letters, manuals, cookbooks, newsletters, etc.; whereas, the opposite is true in schools: About 80% of school reading is long text (Harvey & Goudvis, 2000). Long text tends to present distractions, seemingly complex ideas, and numerous other obstacles to the reader.

Structure

Nonfiction text is framed around several structures (i.e., cause and effect, problem and solution, question and answer, compare and contrast, lists, sequence or series of events; Alvermann & Phelps, 2002) that frequently appear in both textbooks and standardized test forms. Understanding these text structures offers readers chances at determining important information. If students know what to look for in terms of text structure, meaning comes more easily (Harvey & Goudvis, 2000). In addition, the learner’s ability to underline and take appropriate notes is directly related to their understanding of how the text is organized (Woolfolk, 1995). Proficient readers tend to
use the structure of the text to facilitate the recall of the main ideas in the text as well as overall comprehension and recall of the content (Dole, Duffy, Roehler, & Pearson, 1991).

In observing skilled readers, Anderson (1979) reported three levels of information that readers attend to prior to reading text: the nonsentence parts of the text (e.g., headings, pictures), parts of the text that are in predictable places, and selective reading of larger parts of the text. Further, if the text has only paragraphs with no headings or format markings of any kind, the use of strategies typically fail, and the reader resorts to starting at the beginning of the passage and carefully reading each paragraph in order (Anderson, 1979). Overall, regardless of the subject, organized text is remembered better than disorganized text (Danner, 1976) and, thus, text structure has an effect on both recall and the learner’s perceived difficulty of recall (Danner, 1976; Brown & Smiley, 1977).

Medium

It is well known that the medium for responding can significantly influence the learners’ strategic response (Alexander et al, 1998). For instance, when asked to write a paper a student would most likely adjust their planning and strategies of attack depending on whether the paper were to be written using a word processor, a typewriter, or simply paper and pencil. Once a student becomes acclimated to the use of a word processor, the process of writing a paper with a typewriter or paper and pencil is extremely cumbersome.

Research Questions

This study explored the use of a subset of comprehension strategies (i.e., determining importance: underlining, highlighting, and annotating) in both paper and
computer environments. The following questions guided this study:

- To what extent does the use of the selected strategies and medium affect student comprehension and retention?

- Are there significant differences with respect to class, gender, and self-reported computer use on the student’s comprehension and retention?

- To what extent does a participant’s self-reported computer ability, perceived control, and computer awareness play a role in using online strategies?
CHAPTER 3

METHOD

This study explored the effect of the use of determining importance strategies (i.e., underlining, highlighting, and inserting notes in the text) on the processing of nonfiction text in both computer and paper environments.

Participants

The participants for this study were 152 undergraduate students attending Ohio Dominican University, a small, liberal arts institution of higher education in Columbus, Ohio. Participants were solicited from the regularly scheduled semester Liberal Studies courses through a letter to the faculty member teaching each section (see Appendix A). There are two Liberal Studies courses that are part of the core requirements for the university; every student is required to take them both. The first course in the sequence is Liberal Studies I and serves as an introduction to the humanities, covering the intellectual and artistic achievements of humankind through the thirteenth century. The second, Liberal Studies II, continues the exploration of the humanities into the current century with an emphasis on the pursuit of truth in the Dominican intellectual tradition. During the Spring 2003 semester, there were eleven sections of the Liberal Studies I course and seven sections of the Liberal Studies II course on the schedule of classes; hence, the
selection of these courses provided a large enough pool of participants, as well as a broad selection of backgrounds, majors, computer experience, gender, and ethnicity for the study. Students in eight of the sections participated in the study.

The participants included 48 males (31.6%) and 104 females (68.4%), which was closely aligned with the composition of Ohio Dominican’s population. Table 3.1 and Table 3.2 further describe the participants by class, ethnicity, and major according to gender. In addition, participants ranged in age from 17 to 60, with an average of 21.78 years, a median of 20 years, and a mode of 19, with 44 participants (28.9%) reporting an age of 19.

<table>
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<tr>
<th>Class</th>
<th>Male (n=48)</th>
<th>Female (n=104)</th>
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<tbody>
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<td></td>
<td>f (%)</td>
<td>f (%)</td>
<td>f (%)</td>
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<tr>
<td>Freshman</td>
<td>24 (50.0)</td>
<td>37 (35.6)</td>
<td>61 (40.1)</td>
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<td>10 (20.8)</td>
<td>24 (23.1)</td>
<td>34 (22.4)</td>
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<td>Junior</td>
<td>8 (16.7)</td>
<td>37 (35.6)</td>
<td>45 (29.6)</td>
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<td>5 (4.8)</td>
<td>10 (6.6)</td>
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<tr>
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<td>2 (1.3)</td>
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<th>Female (n=104)</th>
<th>Total (n=152)</th>
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<td></td>
<td>f (%)</td>
<td>f (%)</td>
<td>f (%)</td>
</tr>
<tr>
<td>Hispanic</td>
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<td>--</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>African Am.</td>
<td>5 (10.4)</td>
<td>6 (5.8)</td>
<td>11 (7.2)</td>
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<tr>
<td>Caucasian</td>
<td>39 (81.3)</td>
<td>93 (89.4)</td>
<td>132 (86.8)</td>
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<td>Asian/Pacific</td>
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<td>2 (1.9)</td>
<td>2 (1.3)</td>
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<tr>
<td>Native Am.</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Mixed</td>
<td>3 (6.3)</td>
<td>2 (1.9)</td>
<td>5 (3.3)</td>
</tr>
<tr>
<td>Other</td>
<td>--</td>
<td>1 (1.0)</td>
<td>1 (0.7)</td>
</tr>
</tbody>
</table>

Table 3.1: Distributions of class and ethnicity by gender.
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<tr>
<th>Major</th>
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<th>Female (n=104)</th>
<th>Total (n=152)</th>
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<td>Accounting</td>
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<td>3 (1.9)</td>
</tr>
<tr>
<td>Art</td>
<td>2 (4.2)</td>
<td>4 (3.8)</td>
<td>6 (3.9)</td>
</tr>
<tr>
<td>Biology</td>
<td>1 (2.1)</td>
<td>6 (5.8)</td>
<td>7 (4.6)</td>
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<td>Business Administration</td>
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<td>4 (4.8)</td>
<td>14 (9.2)</td>
</tr>
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<td>Business Communications</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Chemistry</td>
<td>--</td>
<td>1 (1.0)</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Communication</td>
<td>1 (2.1)</td>
<td>2 (1.9)</td>
<td>3 (1.9)</td>
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<td>Computer Science</td>
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<td>1 (1.0)</td>
<td>6 (3.9)</td>
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<td>Criminal Justice</td>
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<td>11 (7.2)</td>
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<td>Cross-Disciplinary</td>
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<td>2 (1.9)</td>
<td>3 (1.9)</td>
</tr>
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<td>3 (6.3)</td>
<td>26 (25.0)</td>
<td>29 (19.1)</td>
</tr>
<tr>
<td>Economics</td>
<td>1 (2.1)</td>
<td>1 (1.0)</td>
<td>2 (1.3)</td>
</tr>
<tr>
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<td>--</td>
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<td>1 (0.7)</td>
</tr>
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<td>--</td>
<td>1 (0.7)</td>
</tr>
<tr>
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<td>1 (1.0)</td>
<td>2 (1.3)</td>
</tr>
<tr>
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<td>--</td>
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</tr>
<tr>
<td>International Business</td>
<td>--</td>
<td>2 (1.9)</td>
<td>2 (1.3)</td>
</tr>
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<td>Intervention Specialist</td>
<td>--</td>
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<td>8 (5.3)</td>
</tr>
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</tr>
<tr>
<td>Middle Childhood Education</td>
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<td>10 (6.6)</td>
</tr>
<tr>
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<td>1 (0.7)</td>
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<td>6 (3.9)</td>
</tr>
<tr>
<td>Psychology</td>
<td>2 (4.2)</td>
<td>5 (4.8)</td>
<td>7 (4.6)</td>
</tr>
<tr>
<td>Public Relations</td>
<td>1 (2.1)</td>
<td>2 (1.9)</td>
<td>3 (1.9)</td>
</tr>
<tr>
<td>Secondary Education</td>
<td>4 (8.3)</td>
<td>3 (2.9)</td>
<td>7 (4.6)</td>
</tr>
<tr>
<td>Social Justice</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Social Work</td>
<td>--</td>
<td>1 (1.0)</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Sociology</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>TESOL</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Theology</td>
<td>1 (2.1)</td>
<td>--</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Visual Communications</td>
<td>1 (2.1)</td>
<td>2 (1.9)</td>
<td>3 (1.9)</td>
</tr>
<tr>
<td>Undecided</td>
<td>5 (10.4)</td>
<td>5 (4.8)</td>
<td>10 (6.6)</td>
</tr>
<tr>
<td>Other</td>
<td>--</td>
<td>2 (1.9)</td>
<td>3 (1.9)</td>
</tr>
</tbody>
</table>

Table 3.2: Distributions of major by gender.
At the time this research occurred, every student at Ohio Dominican was required to lease an IBM ThinkPad notebook. Computing staff at Ohio Dominican transformed numerous traditional classrooms into laptop and desktop rooms with appropriate up-to-date video and audio equipment to accommodate and facilitate teaching and learning in a computer environment. As such, one would expect these students to be experienced and, conceivably, comfortable with the use of computers in the learning process. One hundred twenty (78.9%) of the participants reported having taken a computer class or computer training of some kind, while only 18 (11.8%) had created their own personal Web page. As a group, the participants reported spending an average of 21.41 hours a week on the computer, with 31 (20.4%) spending fewer than 10 hours per week, 72 (47.4%) spending between 10 and 20 hours a week, 23 (15.1%) between 21 and 30 hours per week, and 26 (17.1%) spending greater than 30 hours on the computer per week. When asked how often they used the Internet as a source for gathering information, 119 (78.3%) of the participants responded on the upper third (i.e., 7, 8, or 9) of the 9-point Likert scale, ranging from Never (1) to Always (9), with 45 (29.6%) indicating Always (9). In addition, the mean for this response was 7.43 with a standard deviation of 1.50.

Materials

A brief (2,300 words) text concerning the topic of liberal arts education was used for this study. This topic was chosen for its potential interest to students attending a liberal arts university (see Appendix B). The text was written by Robert Harris (1991) and was found on the Internet. This text was selected for its level of information and the perceived ease with which students could outline and organize concepts. In its original
This text was clearly outlined and organized into paragraphs and sections with the leading sentence bolded and the sections marked with Roman and Arabic numerals. These outlining techniques were eliminated from the version used for the study; otherwise, participants would have an inordinate amount of help in the use of strategies and obvious hints to the important material in the text (Anderson, 1979). Additionally, the text was shortened to fit on less than four pages, while the meaning of the text was preserved. The text consisted of a total of 17 paragraphs or 112 sentences. On the average, each paragraph contained 7.4 sentences and each sentence, 20.5 words. The Flesch-Kincard grade level of the text was 12.0 and the readability level registered at 40.4 (as evaluated by Microsoft Word 2000 grammar check). The latter score rates the text on a 100-point scale; the higher the score, the easier it is to understand the document. This rating is calculated using the average sentence length and the average number of syllables per word. Most standard documents aim for a score around 65, so the chosen text was somewhat more difficult to read than most standard documents; therefore, possibly inviting or necessitating the use of strategies (Alexander & Murphy, 1998).

Response Tasks

At the beginning of the project, participants were asked to read and sign an online Informed Consent and fill out a General Information form that asked the participants to provide general demographic information. The remainder of the instrument for this research project consisted of the following measures: computer ability, perceived control, computer awareness, pretest, strategy use, posttest, and retention, which are described
separately in the remainder of this section. The entire instrument can be found in Appendix B.

**Preliminary Measures**

Prior to reading the text, participants were asked to respond to three online measures that would evaluate the participant’s self-reported computer ability, perceived control when using a computer, and computer awareness (Kay, 1990; 1993).

**Computer Ability**

The computer ability measure consisted of five questions presented in a 9-point Likert scale, ranging from Extremely Low (1) to Extremely High (9), with a maximum score of 45 points. Participants were asked to indicate their level of ability in five tasks: using a word processor to create documents, learning a software package that they had never used before, using a graphical user interface, using a disk operating system, and teaching someone to use a computer software package.

**Perceived Control**

The perceived control measure consisted of seven questions presented in a 9-point Likert scale, ranging from Strongly Disagree (1) to Strongly Agree (9), with a total score of 63. This measure asked participants to indicate their opinion on whether they need an experienced person nearby when they use a computer, need someone to tell them the best way to use a computer, could probably teach themselves most of the things they need to know about computers, can make a computer do what they want it to do, have complete control when using the computer, could solve problems if they arose when using the
computer, and prefer to learn new computer software packages on their own. After this preliminary information was gathered, the participants were presented with the pretest.

**Computer Awareness**

The computer awareness measure also consisted of five questions presented in a 9-point Likert scale, ranging from Extremely Low (1) to Extremely High (9), with a maximum score of 45 points. This measure assessed each participant’s level of ability to discuss the strengths and weaknesses of software packages, identify the parts of a computer and their functions, elaborate on various computer applications in society, elaborate on the social and economic impact of computers, and discuss the history of computers.

**Pretest Measure**

A pretest was provided to evaluate the participant’s prior knowledge of the topic and to ensure that participants were statistically equivalent prior to reading the text. During the pretest participants were asked to respond to an online series of nine multiple-choice declarative knowledge questions about the subject of the text. Each of these questions was taken directly from the text that they were about to read and carried a value of one point each. Grading of the pretest involved simply counting the number of correct answers. There was no additional penalty to getting an answer wrong, other than it was not counted as correct, so the pretest carried a maximum score of 9 points.

**Strategy Use Measure**

After reading the text, participants were administered an online questionnaire concerning the types of strategies that they would normally use to process written
nonfiction material. This measure listed eight strategies that are typically used in the reading and processing of text for identifying the important concepts in the text (Harvey & Goudvis, 2000). The strategies included in this measure were underlining important sentences, underlining important words, highlighting important sentences, highlighting important words, skimming or scanning the text before reading, reading only the first and last sentences of each paragraph, writing notes in the text or margins, and outlining the text. Participants were asked to identify the frequency with which they would typically use each of the listed strategies in the studying process. Choices were presented in a pull-down menu, ranging from Always (5) to Never (0). This measure served two purposes. First, it was used as a distraction between the reading and the posttest. Second, it might be a valuable instrument since the level at which a participant would normally use or be aware of using such strategies to process text might be related to the level and/or type of strategies that they would attempt to use in the reading of the text for this study (Paris, Lipson, & Wixson, 1983).

Posttest Measure

After completing the strategy use measure the participants were presented with and asked to respond to the same series of nine declarative knowledge items about the text. This posttest (posttest1) was graded the same as the pretest with a maximum score of 9 points.

Retention Measure

To check retention of the material, participants were administered the same series of nine declarative knowledge items in written format (posttest2) four to six weeks after
the original experience. A paper version of the posttest was used for all participants in order to minimize the equipment and time needed. This measure was graded in the same manner as the previous two evaluative measures; it also had a maximum score of 9 points.

Procedure

A quasi-experimental, within-subjects design was used; classes were randomly assigned to one of four groups. Eight Liberal Studies classes were used for this study, which provided two classes (i.e., one Liberal Studies I and one Liberal Studies II) for each of the four groups. The entire class was assigned to the same group. Participants in all groups received the same initial set of directions (see Appendix C), and were asked to read the same text and respond to the same sequence of online tasks.

There were two between-subjects variables for this study: strategy use and medium. After the initial directions, half of the participants were given instruction on the use of strategies (e.g., underlining, highlighting, inserting notes in the text) in the processing of nonfiction text and the encouragement to use such strategies while reading the text. The other half of the participants received no additional instructions or mention of strategies or the use of strategies. There were also two options for the medium variable: participants read the text either on the computer screen or on paper. Since both the strategy use and medium variables contained two levels, the study involved four groups [i.e., computer, strategy (CS); paper, strategy (PS); computer, no strategy (CN); and paper, no strategy (PN)]. Time (pretest, posttest1, posttest2) was the within-subjects variable (see Table 3.3).
<table>
<thead>
<tr>
<th>Strategy Use</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>Posttest1</td>
</tr>
</tbody>
</table>

Strategies

Computer (CS)
Paper (PS)

No Strategies

Computer (CN)
Paper (PN)

Table 3.3: Experimental design.

Participants in the computer, no strategies (CN) group were asked to read the text online without the ability to use any online processing strategies. The computer, strategies (CS) group was given instruction on the use of strategies via the *Track Changes* feature of Microsoft Word prior to reading and processing the text and given the encouragement to use such strategies while processing the text online. Prior to reading and processing the text in paper format, the paper, strategies (PS) group was given instructions on the use of strategies and the encouragement to use whatever tools (e.g., highlighter, pencil, pen) they would normally use. The paper, no strategies (PN) group read and processed the text in paper format without the ability to write on the paper or use any written strategies (see Table 3.4). The initial process took participants under 45
minutes to complete. Participants completed the retention measure in fewer than five minutes. Participants were given as much time as they needed for all tasks.

<table>
<thead>
<tr>
<th>Strategy Use</th>
<th>Computer</th>
<th>Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategies</td>
<td>CS Group</td>
<td>PS Group</td>
</tr>
<tr>
<td>No strategies</td>
<td>CN Group</td>
<td>PN Group</td>
</tr>
</tbody>
</table>

Table 3.4: Group design.

At the end of the data collection there were 166 participants. After eliminating the 10 incomplete data sets, the computer, no strategies (CN) group and the paper, strategies (PS) group each had 38 participants; the paper, no strategies (PN) group had 39, so to work with an equal number of participants in each group, the middle participant was discarded; and in the computer, strategies (CS) group there were 41 participants, therefore every 13th (41 mod 3) participant was excluded from the data analysis. For data analysis, each group included 38 participants. Once all data were collected, the appropriate fields were translated into SPSS using the translation codes found in Appendix D. Table 3.5 displays the span of time in which this research was developed and implemented.
<table>
<thead>
<tr>
<th>Time Period</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer 2002</td>
<td>– developed Web pages</td>
</tr>
<tr>
<td>October 2002</td>
<td>– solicited participation from Ohio Dominican University</td>
</tr>
<tr>
<td></td>
<td>– Academic Affairs Office</td>
</tr>
<tr>
<td></td>
<td>– Director of Humanities</td>
</tr>
<tr>
<td></td>
<td>– Faculty teaching HUM 110 and HUM 210</td>
</tr>
<tr>
<td>November 2002</td>
<td>– submitted IRB Exemption form to Ohio State University</td>
</tr>
<tr>
<td></td>
<td>– submitted IRB Exemption form to Ohio Dominican University</td>
</tr>
<tr>
<td>December 2002</td>
<td>– ascertained participation from HUM 110 and HUM 210 faculty</td>
</tr>
<tr>
<td>February 2003</td>
<td>– began data collection</td>
</tr>
<tr>
<td>April 2003</td>
<td>– collected posttest2 data</td>
</tr>
<tr>
<td>Summer 2003</td>
<td>– coded and analyzed data</td>
</tr>
</tbody>
</table>

Table 3.5: Research timeline.
CHAPTER 4

RESULTS

This study was guided by three research questions. Each question will be discussed separately in this chapter. Examination of the pretest, posttest1, and posttest2 measures occurred prior to the exploration of these three questions. All data were analyzed using SPSS® 10.0 computer software with an alpha level of .05. Specifying an overall alpha level of .05 with four groups, each containing 38 participants, should provide sufficient power (.70) and a medium effect size for this study (Keppel, 1991).

Test Measures

The descriptive statistics of the three test measures (pretest, posttest1, posttest2) were examined first to establish a basis for further exploration of the data. Each test contained the same series of nine declarative knowledge items, presented in the same order, and each carried a maximum score of 9. All 152 participants took all three test measures.

Descriptive Statistics

Table 4.1 shows the performance score means and standard deviations for the three test measures. Examination of the overall scores reveals that participants performed higher on both posttest1 and posttest2 measures (7.39 and 7.00, respectively).
than on the pretest measure (5.01), with the test that was taken the same day as the reading (posttest1) higher than the test administered four to six weeks later (posttest2).

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Pretest</th>
<th>Posttest1</th>
<th>Posttest2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>76</td>
<td>5.04</td>
<td>7.18</td>
<td>6.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.41</td>
<td>1.37</td>
<td>1.44</td>
</tr>
<tr>
<td>Paper</td>
<td>76</td>
<td>4.97</td>
<td>7.61</td>
<td>7.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.44</td>
<td>1.23</td>
<td>1.65</td>
</tr>
<tr>
<td>Strategies</td>
<td>76</td>
<td>5.17</td>
<td>7.50</td>
<td>7.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.31</td>
<td>1.31</td>
<td>1.62</td>
</tr>
<tr>
<td>No Strategies</td>
<td>76</td>
<td>4.84</td>
<td>7.29</td>
<td>6.96</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.51</td>
<td>1.32</td>
<td>1.50</td>
</tr>
<tr>
<td>Overall</td>
<td>152</td>
<td>5.01</td>
<td>7.39</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.42</td>
<td>1.32</td>
<td>1.56</td>
</tr>
</tbody>
</table>

Table 4.1: Performance score means and standard deviations by medium, strategy use, and overall.

The overall scores in Table 4.1 are not surprising. Participants performed better on the test after the reading (posttest1) than on the test before the reading (pretest), which would be expected. Since the test measures consisted of questions taken directly from the information presented in the text, participants should have been more knowledgeable after the reading. The mean score on the test taken four to six weeks
later (posttest2) is slightly lower than that of the test taken on the same day as the reading of the text (posttest1). This, too, is not surprising since participants would be expected to forget some of the information over time.

Table 4.1 also shows the performance score means and standard deviations grouped by the medium variable (i.e., computer, paper). Half of the participants were asked to read and process the text on the computer screen while the other half were presented the text on paper. The test score mean of the pretest was slightly higher for the computer group (5.04) than the paper group (4.97); whereas, after the reading the opposite is true: mean scores for both posttest1 and posttest2 were substantially higher for the paper group (7.61 and 7.22, respectively) than the computer group (7.18 and 6.78, respectively). The difference between the mean scores at the posttest1 measure (0.43) is virtually the same as the difference at the posttest2 measure (0.44).

To further explore this data, Table 4.1 shows the performance score means and standard deviations separated by the strategy use variable (i.e., strategies, no strategies). Half of the participants were given instruction on the use of the comprehension strategies and encouraged to use them as they processed the reading and the other half of the participants were given neither instruction nor any hint to use such strategies. Inspection of the means and standard deviations show consistently higher mean values on all three measures for the group of participants that used strategies (5.17, 7.50, and 7.04, respectively) than those that did not use strategies (4.84, 7.29, and 6.86, respectively).
To continue the investigation of this data, the individual group statistics were examined. Review of the mean values in Table 4.2 reveals the highest score on the pretest (5.32) was found with the computer, strategies (CS) group; but, on the posttest1 and posttest2 measures, the paper, strategies (PS) group scores are highest (7.82 and 7.34, respectively). It is also noticeable in this table that the paper, strategies (PS) group scored consistently higher than the paper, no strategies (PN) group which scored consistently higher than the computer, no strategies (CN) group on all three test measures. The graph of Figure 4.1 clearly shows these relationships.

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest</th>
<th>Posttest1</th>
<th>Posttest2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer, strategies (CS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>5.32</td>
<td>7.18</td>
<td>6.74</td>
</tr>
<tr>
<td>SD</td>
<td>1.16</td>
<td>1.45</td>
<td>1.45</td>
</tr>
<tr>
<td>Paper, strategies (PS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>5.03</td>
<td>7.82</td>
<td>7.34</td>
</tr>
<tr>
<td>SD</td>
<td>1.44</td>
<td>1.09</td>
<td>1.74</td>
</tr>
<tr>
<td>Computer, no strategies (CN)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>4.76</td>
<td>7.18</td>
<td>6.82</td>
</tr>
<tr>
<td>SD</td>
<td>1.58</td>
<td>1.31</td>
<td>1.45</td>
</tr>
<tr>
<td>Paper, no strategies (PN)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>4.92</td>
<td>7.39</td>
<td>7.11</td>
</tr>
<tr>
<td>SD</td>
<td>1.46</td>
<td>1.35</td>
<td>1.56</td>
</tr>
</tbody>
</table>

Note: Each group contained thirty-eight (38) observations.

Table 4.2: Performance score means and standard deviations by group.
Figure 4.1 shows the graph of the data presented in Table 4.2 by test measure. Although the computer, strategies (CS) group performed better on the pretest measure than the other three groups, this group had the lowest mean score on both the posttest1 (tied with CN group) and posttest2 measures; so, it appears that not only did the computer, strategies (CS) group learn less from the reading, but they retained less than the other three groups. Also of interest, the two paper (PS and PN) groups performed better on both the posttest measures than the two computer (CS and CN) groups. It seems that the paper, strategy (PS) group learned and retained more from the text than the other three groups.
From this analysis, it is apparent that there is some difference in the group mean values for medium, especially at the posttest1 and posttest2 measures where the paper groups (PS and PN) outperform both computer groups (CS and CN). It is also evident that the computer, strategies (CS) group was quite unpredictable on the test measures, which may affect the significance of the comprehension and retention measures.

Design of the Study

A quasi-experimental, within-subjects design was used in this research, employing strategy use and medium as the between-subject variables and time (i.e., pretest, posttest1, and posttest2) as a within-subjects variable; however, the questions by which this research was guided deal with the concepts of comprehension and retention of information. Consequently, for the purpose of analysis, the comprehension score was
calculated by subtracting the pretest score from the posttest1 score (posttest1 – pretest) and represents the amount of gain from reading and processing the text. The retention score was calculated by subtracting the pretest score from the posttest2 score (posttest2 – pretest) and represents the amount of information retained after the four to six week span.

Question 1

To what extent does the use of the strategies for determining importance (i.e., underlining, highlighting, and writing notes within the text) and medium (i.e., computer and paper) affect student comprehension and retention?

Hypotheses

The tested hypothesis for the comprehension measure was that the mean values for the comprehension scores (posttest1 – pretest) of the four groups (CS, CN, PS, and PN) would be equal. The alternative hypothesis is that there is some difference in the mean values of the four groups on the comprehension measure. Likewise, the null hypothesis for the retention measure was that the mean retention scores (posttest2 – pretest) of the four groups would be equal. The alternative hypothesis was that there is some difference in the mean retention scores of the four groups; namely, the use or non-use of strategies and/or reading the text on the computer or paper affects retention of the text.

Descriptive Statistics

Table 4.3 shows the individual group and overall means and standard deviations values for the comprehension and retention measures. The paper, strategy (PS) group
performed highest on both the comprehension and retention measures (2.79 and 2.32, respectively). The computer, strategies (CS) group performed considerably lower on both the comprehension and retention measures (1.87 and 1.42, respectively) than all other groups. The paper, no strategies (PN) group performed better on both the comprehension and retention measures (2.47 and 2.18, respectively) than the computer, no strategies (CN) group (2.42 and 2.05, respectively). Figure 4.3 shows the graph of these comprehension and retention score means.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Comprehension</th>
<th>Retention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(Posttest1 – Pretest)</td>
<td>(Posttest2 – Pretest)</td>
</tr>
<tr>
<td>Computer, strategies (CS)</td>
<td>38</td>
<td>1.87</td>
<td>1.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.53</td>
<td>1.46</td>
</tr>
<tr>
<td>Paper, strategies (PS)</td>
<td>38</td>
<td>2.79</td>
<td>2.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.68</td>
<td>2.16</td>
</tr>
<tr>
<td>Computer, no strategies (CN)</td>
<td>38</td>
<td>2.42</td>
<td>2.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.67</td>
<td>1.75</td>
</tr>
<tr>
<td>Paper, no strategies (PN)</td>
<td>38</td>
<td>2.47</td>
<td>2.18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.41</td>
<td>1.87</td>
</tr>
<tr>
<td>Overall</td>
<td>152</td>
<td>2.39</td>
<td>1.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.59</td>
<td>1.84</td>
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</tbody>
</table>

Table 4.3: Comprehension and retention score means and standard deviations by group and overall.
Analysis of Variance

Assumptions

Since analysis of the data involved the analysis of variance the assumptions of independence of observations, normal distributions, and homogeneity of variance were checked. Independent observations is preserved in this data—each score appears only once in the data and each participant is not related to any other participant in the study. Participants were accessed through the class in which they were scheduled. Each class was randomly assigned to the group condition (i.e., CS, CN, PS, and PN). Instructions were presented to the class as a unit; however, participants individually responded to the measures in the study via a separate personal computer. The histograms in Figure 4.4 and Figure 4.5 support the assumption of normal distribution on the overall comprehension and retention measures and are representative of the individual group histograms.
Figure 4.4: Histogram for comprehension measure.

Figure 4.5: Histogram for retention measure.
To confirm that the population variance-covariance matrices for the dependent variables were equal across the groups, the Levene statistic was generated. Both the comprehension $[F(3,148)=0.53, \alpha=.66]$ and retention $[F(3,148)=0.77, \alpha=.51]$ measures satisfy this test.

**Analysis**

**Comprehension.** To investigate the comprehension measure, the data were submitted to analysis of variance with strategy and medium as independent variables, and the difference of the posttest1 and pretest scores as the dependent variable. The results revealed an almost significant effect for medium $[F(1,148)=3.63, p=.059, \eta^2=.024]$, but no significant effect for strategy $[F(1,148)=2.15, p=.644, \eta^2=.001]$ and no significant strategy-by-medium interaction $[F(1,148)=2.89, p=.091, \eta^2=.019]$ on the comprehension measure at the .05 level (see Table 4.4).

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>Eta Sqr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy</td>
<td>1</td>
<td>0.53</td>
<td>0.53</td>
<td>0.22</td>
<td>.001</td>
</tr>
<tr>
<td>Medium</td>
<td>1</td>
<td>9.01</td>
<td>9.01</td>
<td>3.62*</td>
<td>.024</td>
</tr>
<tr>
<td>Strategy*Medium</td>
<td>1</td>
<td>7.16</td>
<td>7.16</td>
<td>2.89**</td>
<td>.019</td>
</tr>
<tr>
<td>Error</td>
<td>148</td>
<td>367.40</td>
<td>2.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>151</td>
<td>384.10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $p = .059$, ** $p < .1$

Table 4.4: ANOVA of comprehension scores by strategy and medium.
Since the medium variable was close to significant at .059 and the strategy-by-medium interaction was significant at an alpha level of .10, further investigation was pursued. Figure 4.6 shows the graph of the mean values of Table 4.3. In this graph paper is consistently above computer and there is little variation in the mean scores of the no strategies groups (CN=2.42, PN=2.47). To investigate this interaction an analysis of the simple effects of medium was performed. The results revealed a significant effect at the .05 level for the medium variable for those who used strategies \[F(1,148)=6.26, \quad p=.015, \quad \eta^2=.078\] and no significant effect for those who did not use strategies \[F(1,148)=0.02, \quad p=.882, \quad \eta^2<.001\] (see Table 4.5).

![Figure 4.6: Strategy-by-medium interaction on the comprehension measure.](image_url)
<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>η²</th>
<th>Eta Sqr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium at Strategies</td>
<td>1</td>
<td>16.12</td>
<td>16.12</td>
<td>6.26*</td>
<td>.078</td>
<td></td>
</tr>
<tr>
<td>Medium at No strategies</td>
<td>1</td>
<td>0.05</td>
<td>0.05</td>
<td>0.02</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>148</td>
<td>367.40</td>
<td>2.48</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < .05

Table 4.5: Analysis of the simple effects of medium.

Retention. To investigate the retention measure, the data were submitted to analysis of variance with strategy and medium as independent variables, and the difference of the posttest2 and pretest scores as the dependent variable. The results revealed no significant effects for strategy \(F(1,148)=0.71, p=.401, \eta^2=.005\) or medium \(F(1,148)=2.99, p=.086, \eta^2=.020\), and no significant strategy-by-medium interaction \(F(1,148)=1.65, p=.200, \eta^2=.011\) on the retention measure at an alpha level of .05 (see Table 4.6). At an alpha level of .10 medium is significant.
Table 4.6: ANOVA of retention scores by strategy and medium.

** p < .1

**Question2**

Are there significant differences with respect to class, gender, and self-reported computer use on the student’s comprehension and retention?

**Hypotheses**

The tested hypotheses for the comprehension and retention measures were that class, gender, self-reported computer use, or any combination of these three variables would influence the mean comprehension (posttest1 – pretest) or retention (posttest2 – pretest) scores, respectively for any of the four groups (CS, CN, PS, PN). The alternative hypotheses were that class, gender, computer use, or some combination of class, gender, and computer use would affect the mean comprehension and retention scores.
Descriptive Statistics

Class was self reported on the demographic questionnaire via a pulldown menu with the selections of Freshman (1), Sophomore (2), Junior (3), Senior (4), and Other (0). Gender was also self reported on the demographic questionnaire as a bubble selection between Male (1) and Female (2). Computer use was self reported on the demographic questionnaire in the “Indicate the frequency with which you use the computer for the following: School-Related Activities, Work-Related Activities, Home-Related Activities, and Entertainment Activities” question. Each of the four groups of activities had the choices: Never (0), Less than once a week (1), Once a week (2), 2-3 times a week (3), 4-6 times a week (4), Daily (5). From the responses, a computer use score (maximum = 20) was calculated for each participant—the higher the score, the higher the overall computer use.

Table 4.7 shows the frequencies and percentages for each of the groups under the gender and class variables. There was more than twice the number of females participating in this research than males. That statistic pretty much holds for individual groups except the computer, strategy (CS) group, where the males make up 42% of the group. Each of the classes was nicely represented in this study. According to the core curriculum at Ohio Dominican, the majority of the students in HUM 110 and HUM 210 should be freshmen and sophomores, which holds for this study with 62.5% of the participants at the freshman and sophomore level.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>CN ( f(%) )</th>
<th>CS ( f(%) )</th>
<th>PS ( f(%) )</th>
<th>PN ( f(%) )</th>
<th>Overall ( f(%) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>13(34.2)</td>
<td>16(42.1)</td>
<td>10(26.3)</td>
<td>9(23.7)</td>
<td>48(26.4)</td>
</tr>
<tr>
<td>Female</td>
<td>25(65.8)</td>
<td>22(57.9)</td>
<td>28(73.7)</td>
<td>29(76.3)</td>
<td>104(68.4)</td>
</tr>
<tr>
<td>Class</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>18(47.4)</td>
<td>12(31.6)</td>
<td>15(39.5)</td>
<td>16(42.1)</td>
<td>61(40.1)</td>
</tr>
<tr>
<td>Sophomore</td>
<td>10(26.3)</td>
<td>11(28.9)</td>
<td>6(15.8)</td>
<td>7(18.4)</td>
<td>34(22.4)</td>
</tr>
<tr>
<td>Junior</td>
<td>9(23.7)</td>
<td>11(28.9)</td>
<td>14(36.8)</td>
<td>11(28.9)</td>
<td>45(29.6)</td>
</tr>
<tr>
<td>Senior</td>
<td>--</td>
<td>4(10.5)</td>
<td>3(7.9)</td>
<td>3(7.9)</td>
<td>10(6.6)</td>
</tr>
<tr>
<td>Other</td>
<td>1(2.6)</td>
<td>--</td>
<td>--</td>
<td>1(2.6)</td>
<td>2(1.3)</td>
</tr>
</tbody>
</table>

Note: Each group contained thirty-eight (38) observations.

Table 4.7: Gender and class distributions by group.

Figure 4.7 displays the frequencies on the computer use measure. The majority of the scores (65%) are in the 11 to 16 range. The overall mean for computer use was 12.55 with a standard deviation of 3.54. Table 4.8 shows the means and standard deviations for the computer use measure by group. Examination of these values reveals that the computer, strategies (CS) group has the highest mean (13.13), but also the highest variance (SD=3.89) on the computer use measure, and the paper, no strategy (PN) group had the lowest mean (12.24).
Figure 4.7: Computer use frequencies.

<table>
<thead>
<tr>
<th>Factors:</th>
<th>Strategy Use</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy Use</td>
<td>Medium</td>
<td>Min</td>
<td>Max</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Strategies</td>
<td>Computer (CS)</td>
<td>6</td>
<td>20</td>
<td>13.13</td>
<td>3.89</td>
</tr>
<tr>
<td></td>
<td>Paper (PS)</td>
<td>5</td>
<td>19</td>
<td>12.42</td>
<td>3.14</td>
</tr>
<tr>
<td>No Strategies</td>
<td>Computer (CN)</td>
<td>2</td>
<td>20</td>
<td>12.39</td>
<td>3.66</td>
</tr>
<tr>
<td></td>
<td>Paper (PN)</td>
<td>4</td>
<td>19</td>
<td>12.24</td>
<td>3.48</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td>2</td>
<td>20</td>
<td>12.55</td>
<td>3.54</td>
</tr>
</tbody>
</table>

Note: Each group contained thirty-eight (38) observations.

Table 4.8: Computer use means and standard deviations by group.
Analysis of Variance

Comprehension

To examine the comprehension issue, a three-way univariate ANOVA with class, gender, and overall computer use as the factors, and the comprehension score (posttest1 – pretest) as the dependent variable was performed. Table 4.9 shows the results of this analysis which found no significant effects for class [$F(4,80)=0.50$, $p=.734$, $\eta^2=.025$], gender [$F(1,80)=0.08$, $p=.785$, $\eta^2=.001$], or computer use [$F(17,80)=1.02$, $p=.447$, $\eta^2=.178$], and no significant interactions among these factors.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>4</td>
<td>5.36</td>
<td>1.34</td>
<td>0.50</td>
<td>.025</td>
</tr>
<tr>
<td>Gender</td>
<td>1</td>
<td>0.20</td>
<td>0.20</td>
<td>0.08</td>
<td>.001</td>
</tr>
<tr>
<td>Computer Use</td>
<td>17</td>
<td>46.21</td>
<td>2.72</td>
<td>1.02</td>
<td>.178</td>
</tr>
<tr>
<td>Class * Gender</td>
<td>3</td>
<td>6.72</td>
<td>2.24</td>
<td>0.84</td>
<td>.031</td>
</tr>
<tr>
<td>Class * CU</td>
<td>24</td>
<td>49.09</td>
<td>2.05</td>
<td>0.77</td>
<td>.187</td>
</tr>
<tr>
<td>Gender * CU</td>
<td>9</td>
<td>12.52</td>
<td>1.39</td>
<td>0.52</td>
<td>.055</td>
</tr>
<tr>
<td>Class * Gender * CU</td>
<td>10</td>
<td>29.95</td>
<td>3.00</td>
<td>1.12</td>
<td>.123</td>
</tr>
<tr>
<td>Error</td>
<td>80</td>
<td>213.23</td>
<td>2.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>151</td>
<td>384.10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.9: ANOVA of comprehension scores by class, gender, and computer use.

Retention

To explore the retention measure, a three-way univariate ANOVA with class, gender, and overall computer use as the factors, and the retention score (posttest2 –

59
pretest) as the dependent variable was performed. Table 4.10 shows the results of this analysis. An almost significant main effect for computer use was found \([F(17,80)=1.71, \ p=.059, \ \eta^2=.266]\) at an alpha level of .05. At the .10 level there is a significant gender-by-computer use interaction \([F(9,80)=1.84, \ p=.074, \ \eta^2=.171]\) and a significant class-by-gender-by-computer use interaction \([F(10,80)=1.72, \ p=.090, \ \eta^2=.177]\).

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>Eta Sqr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>4</td>
<td>14.03</td>
<td>3.51</td>
<td>1.13</td>
<td>.054</td>
</tr>
<tr>
<td>Gender</td>
<td>1</td>
<td>1.84</td>
<td>1.84</td>
<td>0.60</td>
<td>.007</td>
</tr>
<tr>
<td>Computer Use</td>
<td>17</td>
<td>89.82</td>
<td>5.28</td>
<td>1.71*</td>
<td>.266</td>
</tr>
<tr>
<td>Class * Gender</td>
<td>3</td>
<td>6.62</td>
<td>2.21</td>
<td>0.71</td>
<td>.026</td>
</tr>
<tr>
<td>Class * CU</td>
<td>24</td>
<td>56.05</td>
<td>2.34</td>
<td>0.75</td>
<td>.184</td>
</tr>
<tr>
<td>Gender * CU</td>
<td>9</td>
<td>51.16</td>
<td>5.69</td>
<td>1.84**</td>
<td>.171</td>
</tr>
<tr>
<td>Class * Gender * CU</td>
<td>10</td>
<td>53.37</td>
<td>5.34</td>
<td>1.72**</td>
<td>.177</td>
</tr>
<tr>
<td>Error</td>
<td>80</td>
<td>247.77</td>
<td>3.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>151</td>
<td>512.99</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* \(p = .059\), ** \(p < .1\)

Table 4.10: ANOVA of retention scores by class, gender, and computer use.

To further investigate the class-by-gender-by-computer use interaction, subsequent two-way ANOVAs were performed. Results reveal a gender-by-computer use interaction for both juniors \([F(4,26)=4.36, \ p=.008, \ \eta^2=.401]\) and seniors \([F(2,3)=18.21, \ p=.021, \ \eta^2=.924]\). To follow up on these interactions, analysis of the simple effects of computer use was generated for males and females at the junior and
senior levels of class. Results revealed a significant effect for computer use at the .05 level for females who are seniors \(F(2,2)=21.20, p=.045, \eta^2=.955\) and at the .10 level for males who are juniors \(F(5,2)=9.98, p=.094, \eta^2=.961\).

Question 3

To what extent does a participant’s self-reported computer ability, perceived control, and computer awareness play a role in using online strategies?

Hypotheses

The tested hypotheses were that there would be no relationship between computer ability, computer awareness, or perceived control and the comprehension and retention of the text for the group using online strategies—the computer, strategy (CS) group. The alternative hypothesis was that there would be some relationship between computer ability, computer awareness, or perceived control, and comprehension and retention of the text for the computer, strategy (CS) group.

Descriptive Statistics

Each participant completed a five-item computer ability measure and a five-item computer awareness measure. Each of the items was in a modified Likert scale, ranging from extremely low (1) to extremely high (9), so each participant has a computer ability score (maximum of 45) and a computer awareness score (maximum of 45). In addition, each participant completed a seven-item perceived control measure. Each item of this measure was in a modified Likert scale, ranging from strongly disagree (1) to strongly agree (9). That measure provided each participant a perceived control score (maximum of 63). Adding these three scores together gives a maximum computer perception score.
of 153. Since this question addresses only the use of online comprehensive strategies, the computer, strategy (CS) group was the only group examined. Table 4.11 shows the minimum and maximum scores, as well as the means and standard deviations on these measures.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Min</th>
<th>Max</th>
<th>Mean(Total)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Ability</td>
<td>11</td>
<td>42</td>
<td>28.29(45)</td>
<td>8.46</td>
</tr>
<tr>
<td>Computer Awareness</td>
<td>9</td>
<td>41</td>
<td>25.21(45)</td>
<td>8.99</td>
</tr>
<tr>
<td>Perceived Control</td>
<td>12</td>
<td>63</td>
<td>44.47(63)</td>
<td>14.43</td>
</tr>
<tr>
<td>Computer Perception</td>
<td>32</td>
<td>146</td>
<td>97.97(153)</td>
<td>29.13</td>
</tr>
</tbody>
</table>

Note: Thirty-eight (38) observations.

Table 4.11: Computer perception means and standard deviations for the computer, strategy (CS) group.

Examination of these values shows that participants rated themselves rather high on the three measures of computer ability, computer awareness, and perceived control. The mean scores on these three measures are above 60% of the total score, with the perceived control score at 70.6% (44.47/63). This means that overall, participants were reasonably confident in their own computer abilities.

Correlation Analysis

Assumptions

There are two assumptions that need to be checked prior to running a correlation analysis: existence of outliers and a linear relationship. Since the variables of interest
are computer ability, computer awareness, and perceived control, boxplots were generated to explore the existence of outliers within these scores. Figure 4.8 indicates no outliers in the data from the three variables for the computer, strategy (CS) group.

Figure 4.8: Boxplots of computer ability, computer awareness, and perceived control variables for the computer, strategy (CS) group.

Evidence of a linear relationship was explored by generating a scatterplot matrix including the variables of computer ability, computer awareness, and perceived control. Figure 4.9 shows the relatively linear relationship between all combinations of the three variables.
Figure 4.9: Scatterplot matrix of computer ability, computer awareness, and perceived control for the computer, strategy (CS) group.

Analysis

To examine the relationship between the overall computer perception and comprehension, a bivariate Pearson correlation was performed with computer ability, computer awareness, perceived control, comprehension, and retention as the variables. Kay (1993) has previously verified the high and significant correlation among computer ability, computer awareness, and perceived control in his research. Table 4.12 shows the significant correlation among the computer ability, computer awareness, and perceived control variables, as well as between the comprehension and retention measures, but no
significant correlation between any of the three computer variables and either the comprehension or retention measure for this particular group of participants.

<table>
<thead>
<tr>
<th>Subscale</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Computer ability</td>
<td>--</td>
<td>.64*</td>
<td>.86*</td>
<td>-.13</td>
<td>-.12</td>
</tr>
<tr>
<td>2. Computer awareness</td>
<td>--</td>
<td>.70*</td>
<td>-.19</td>
<td>-.26</td>
<td></td>
</tr>
<tr>
<td>3. Perceived control</td>
<td>--</td>
<td>-.16</td>
<td>-.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Comprehension</td>
<td>--</td>
<td></td>
<td></td>
<td>.68*</td>
<td></td>
</tr>
<tr>
<td>5. Retention</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < .01
Note: Thirty-eight (38) observations.

Table 4.12: Correlation between computer variables and comprehension/retention for the computer, strategy (CS) group.
CHAPTER 5

DISCUSSION

This study was guided by three research questions, each of which will be discussed separately in this chapter. A discussion of the possible limitations of this study will occur first.

Limitations of the Study

Participants were accessed through the class in which they were scheduled. Students often sign up for the classes that their friends are signed up for or for classes that occur within a particular time of day, particular days of the week, etc. This may contribute to a more homogeneous group than the population the participants were part of—individual classes were selected, not individual students. The decision to participate or not was determined by the instructor of the course, not the individual student.

The majority (62.5%) of the participants were at the freshman and sophomore level of college course work. This statistic was not surprising since the Liberal Studies courses are part of the core curriculum and are usually taken at the freshman and sophomore levels, but may be connected to the student’s academic maturity level and thus their ability to read and process text, whatever the medium. Part of the discussion on the use of strategies in the research literature supports the idea that students learn and
develop the appropriate learning and study skills as they age and move forward in school (Brown et al., 1983). Weinstein and colleagues (1988/1989) though, would argue that “many students do not develop effective learning strategies unless they receive explicit instruction in their use” (p. 17). The current research did not analyze the participant’s experience with and development of the use of strategies in learning environments. The participants could have, in fact, used strategies other than underlining, highlighting, and writing notes within the text while they were reading and processing the text.

The sample was fairly representative of Ohio Dominican’s distribution of majors, except for the number of education majors. About a third (35.5%) of the participants reported a major of education, which is slightly above the population of education majors on the campus (~25%). Of the thirty-eight participants in the paper, no strategy (PN) group, sixteen (42.1%) reported a major of education. This may over represent a particular group from the total population and therefore, under represent other majors from this population.

Although, participants were not timed on the reading, they were not given the opportunity to go back and reread or check any of the text. They were instructed to follow the links and go forward in the research instrument, and not to use the back arrow that is typically found on every Web page. Participants completed the project in a computer classroom where every computer screen was visible to the researcher and participants knew that they were being watched.
Another possible concern in this research is the reliability of the multiple choice test items on the three test measures (pretest, posttest1, and posttest2). Each of the three test measures contained the same nine questions, in the same order. This results in consideration of a practice effect. Did participants perform better on the posttest1 measure because they learned from the text or because they had seen the questions before? Did the pretest measure prompt the participants to pay attention to certain information in the text? Granted, participants did not know that they were going to see the same sequence of questions again on a posttest measure but, pretests can serve to warn participants about what is to come (Keppel, 1991).

Conclusions

The results of the appropriate statistical testing were reported in Chapter 4. The purpose of the discussion presented here is to clarify the significance, the patterns, and any relationships with findings from previous research.

Question 1

To what extent does the use of the selected strategies and medium affect student comprehension and retention?

On the comprehension measure the medium variable was close to the significance level of .05 set in the design of the research at .059 and the strategy-by-medium interaction was significant at an alpha level of .091. Analysis of the simple effects of medium was performed to investigate the interaction. As expected from the graph of Figure 4.6, the results revealed a significant effect at the .05 level for the medium variable only for the two groups who used strategies (i.e., CS and PS). Since
medium cannot be interpreted independently of strategy use in this research, the only viable conclusions are that the paper, strategy (PS) group significantly outperformed the computer, strategy (CS) group and with the groups that did not use strategies (CN and PN) there was no difference.

On the retention measure, medium was significant at an alpha level of .10. Since there was no significant interaction, the main effect for medium could be considered without influence by the strategy use variable. In this case, those who read and processed the text on paper (PS and PN) outperformed those who read and processed the text from the computer screen (CS and CN), regardless of using or not using strategies.

The issue of medium and its effect on learning has been heavily debated in the literature. Clark (1983) contends that the choice of medium has no affect on learning or the motivation to learn. Technology is simply a tool to facilitate delivery, much like the overhead projector. Several researchers would agree that computer technology provides the tools for learning, but argue that computer technology can also enhance the motivation to learn and, thus allow for the possibility of an immense improvement in reading, listening, and writing skills (Bagui, 1998; Becker, 2000; Kelly & Lockbee, 1998; Kozma, 1991; Olgren, 2000). In this view, technology supplies the fundamental tools for the engagement and enhancement of learning.

When comparing paper and online media, previous research has found that participants reading text from the computer screen perform as well on evaluative measures as participants reading the same text on paper (Murphy, Long, Holleran, &
The current research clearly supports paper as the better medium, especially when asked to recall information four to six weeks later. Using or not using the selected strategies made no significant difference, regardless of the medium.

**Question 2**

Are there significant differences with respect to class, gender, and self-reported computer use on the student’s comprehension and retention?

For the comprehension measure, test results showed no significant effects for class, gender, or overall computer use, and no significant interactions among these factors at either the .05 or .10 levels of significance. On the retention measure, the main effect for computer use was significant at the .059 level, the gender-by-computer use interaction was significant at an alpha level of .074, and a class-by-gender-by-computer use interaction was significant at .090. Further investigation revealed a significant effect for computer use at the .045 level for female seniors and at the .094 level for male juniors. There were only five females at the senior class level (see Table 3.1) and the mean computer use score for these participants was 11.6 with a standard deviation of 0.89. For the eight male juniors the mean computer use score was 12.63 with a standard deviation of 4.24. These scores represent neither the lowest nor the highest mean scores on the overall computer use item, so were not noticed when describing the data in previous chapters.

Junior and senior students enrolled in Liberal Studies courses at Ohio Dominican usually represent either transfer students or adult students who have been in
school for a while. This maturity with schooling might have a direct affect—either negatively or positively—on computer use. A standard deviation of 4.24 is quite high on an item with only a maximum score of 20. This would indicate that the male juniors probably had some of the lowest, as well as some of the highest individual scores on this item. It is difficult to determine why results are significant for only female seniors and male juniors without examining additional information. It is also most unlikely that these results would be replicated in future research.

Question 3

To what extent does a participant’s self-reported computer ability, perceived control, and computer awareness play a role in using online strategies?

There was a significant correlation among the computer ability, computer awareness, and perceived control variables, as well as between the comprehension and retention measures, but no significant correlation between any of the computer variables and either the comprehension or retention measure. Correlation coefficients in Table 4.12 indicate a relatively weak linear association between the computer variables and both the comprehension and retention measures. In addition, the negative values give an indication of a slight indirect relationship—as the computer perception score increases, the comprehension and retention scores decrease. Only 3% of the variance in the comprehension measure and 4.8% of the variance in the retention measure can be attributed to the overall computer perception variable. These are relatively low values and quite unexpected. Perhaps, since Ohio Dominican is a computer-required campus, students were not only more comfortable and experienced with the use of a computer,
but also had a greater sense of what they could do with a computer than the average college student.

Implications

The role of technology is not to be a delivery system but rather to be an environment that enables learning. The role of teaching is not simply to convey information but rather to engage students in actively constructing knowledge. The challenge of teaching with technology is to create a learning design that cues and supports the full repertoire of learning strategies. (Olgren, 2000, p. 15)

The challenge that technology introduces to the classroom environment has often been overlooked or treated as an obvious advantage rather than as the challenge it is. The effective use of technology in schools goes beyond just dropping computers into the classroom (Dwyer, 1994). Technology has the capacity to engage students in higher order cognitive tasks at the same time it is prompting teachers to question their tried-and-true assumptions about instruction and learning (Dwyer, 1994).

The computer, with its hypermedia, multimedia, and hyperlink capabilities, is more prevalent in today’s classrooms than ever before. In addition, a number of students arrive at college with ability, awareness, and control of the technology typically found on the campus. Future research should explore additional learning strategies in computer environments. What does it mean to read and process text when
that text is presented on a computer screen? The current research explored text presented in a linear format, but what happens when the text moves to the nonlinear presentation typically found on the Web and other hyperlinked environments? Perhaps the strategies needed to take advantage of such nonlinear presentations are quite different than those used in the reading and processing of linear text (Alexander, in press).

Researchers believe that expertise in any domain demands the knowledge of the use of strategies and the development of strategic processing (Alexander, Graham, & Harris, 1998). This development needs to occur within the confines of the tools that are prevalent in today’s classroom. As computers become a more obvious part of the learning process and students become more and more comfortable with and in control of computer technology, instruction and learning must adjust to take full advantage.
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APPENDIX A

LETTER TO FACULTY
Dear Humanities Faculty at Ohio Dominican University,

The purpose of this letter is to ask for the participation of your students in a study entitled “Use of Strategies for the Comprehension and Retention of Nonfiction Text in Computer Environments.” This project will be conducted during the Spring 2003 semester at Ohio Dominican University under the direction of Professor Suzanne Damarin of The Ohio State University by Theresa Holleran, faculty member in the Division of Mathematics and Information Sciences at Ohio Dominican University and Ph.D. candidate in the College of Education at The Ohio State University.

The participants for this study will be approximately 120 undergraduate students attending Ohio Dominican University. Participants will be solicited from the Humanities 110 and 210 classes and will be offered course credit or extra credit, as determined by you, their course instructor. This pool was selected so as to guarantee a large enough pool of participants, as well as a broad selection of backgrounds, majors, computer experience, gender, and ethnicity.

A four-page (2,300 word) article will be used for this study. This nonfiction text was chosen for its content and potential interest to students at a liberal arts university. The study will be performed early in the course (preferably before January 31). Prior to reading the text participants will be asked to read and sign an online consent form, respond to an online questionnaire seeking demographic information (e.g., age, gender, major, ethnicity), respond to an online series of questions (seventeen 9-point Likert scale items) concerning perceived computer ability and control, and then respond to an online series of multiple choice declarative knowledge items about the topic. After reading the text online, participants will be administered an online questionnaire about their use of strategies when reading and an additional online series of declarative knowledge items about the topic. The entire process should take about sixty minutes to complete. Two weeks after the original session students will be asked to respond to a short, 5-minute written questionnaire about the topic.

All data from the study will be coded to insure the confidentiality of the student in the reporting of the results. Only trained data analysts will have access to the data and they will be bound by a strict code of confidentiality. Possible risk factors from the participation of your students are no greater than normal school activity.

Participation in this study is completely voluntary and your decision regarding the participation of your class in this study will not affect your relations with Ohio Dominican University, The Ohio State University, or Theresa Holleran in any way. If you decide to participate, you are free to withdraw your consent and discontinue your participation at any time. If you have any questions or concerns, please contact Theresa Holleran at 251-4586 or hollerat@ohiodominican.edu.

Thank you,

(sig)
Consent for Participation

Please complete this form and return to Theresa Holleran’s mailbox in Erskine 132A.

☐ I AGREE

☐ I DO NOT AGREE

to allow my Spring 2003, HUM 110 / HUM 210 class to participate in the research entitled *Use of Strategies for the Comprehension and Retention of Nonfiction Text in Computer Environments*. I understand that the study will take about forty-five minutes of my class time and I am free to designate the preferred date and time for the administration and completion of the study. I also agree to allow my students to complete a 5-minute questionnaire at the end of the class that would fall exactly two weeks after the participation in the original study.

Students will need access to the Web and thus, will be administered the study in the regularly assigned computer or laptop room. If your class meets in a regular classroom (non-computer/laptop), it will be moved to a computer room for the duration of the study.

I understand that I have the opportunity to obtain additional information regarding the study. Furthermore, I understand that I am free to withdraw consent at any time and to discontinue participation in the study without prejudice to me by contacting Theresa Holleran (251-4586 or hollerat@ohiodominican.edu).

I acknowledge that I have read and fully understand the consent form. I sign it freely and voluntarily. Please make a copy of this form for each Humanities class that you have.

__________________________________________________________________________  ________________
Faculty Member                          Date

___________________________________  ______________________________
Class          Section             Assigned Classroom

___________________________________
Preferred Date for Participation

___________________________________
Start Time for the Study (please allow an hour at the beginning or ending of class)
APPENDIX B

INSTRUMENT
INFORMED CONSENT

Use of Strategies for the Comprehension and Retention of Nonfiction Text in Computer Environments

I consent to participate in the above research project that is being conducted by Theresa Holleran under the guidance of Dr. Suzanne Damarin of The Ohio State University.

I understand that I will be required to provide some background information, respond to some questionnaires, and read a multipage text. The entire procedure is expected to take me approximately 40 minutes to complete.

In consenting to this project, I understand that I am guaranteed confidentiality in the reporting of results, and that my name will not be used at any time. I have also been informed that my participation is voluntary, and that I may ask questions or withdraw from the study at any time without risk.

I understand that the study will be beneficial in clarifying how the background and ability of students, like myself, may influence how computers are utilized in classroom instruction. Further, I understand that marking the circle below next to the “agree” choice is a way of signifying my consent to participate in this study.

☐ I AGREE to participate.

☐ I DO NOT AGREE to participate.

Signature ____________________________

Submit Form
General Information

Please identify and describe yourself:

Group

Age

Sex  ☐ Male  ☐ Female

Please indicate your major(s):

Accounting

Please indicate your ethnicity:

Please indicate your year in college:

Approximately how many hours per week do you spend using a computer?

Indicate the frequency with which you use the computer for the following:

School-Related Activities

Work-Related Activities

Home-Related Activities

Entertainment Activities

Have you taken any computer course or training?  ☐ Yes  ☐ No

Do you have your own personal Web page?  ☐ Yes  ☐ No

How often do you use the Internet as a source for gathering information?

Never  ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ Always

Submit Form
COMPUTER ABILITY

Mark the circle on the line below each statement that most closely indicates your level of ability with computers. I am able to

1. use a word processor to create documents.

2. learn a software package that I've never used before.

3. use a graphical user interface (e.g., Windows, MacOS).

4. use a disk operating system (e.g., DOS, OS10).

5. teach someone to use a computer software package.
PERCEIVED CONTROL

Mark the circle on the line below each statement that most closely indicates your position on the statement.

1. I do not need an experienced person nearby when I use a computer.
   Strongly Disagree [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] Strongly Agree

2. I do not need someone to tell me the best way to use a computer.
   Strongly Disagree [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] Strongly Agree

3. I could probably teach myself most of the things I need to know about computers.
   Strongly Disagree [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] Strongly Agree

4. I can make the computer do what I want it to do.
   Strongly Disagree [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] Strongly Agree

5. I am in complete control when I use the computer.
   Strongly Disagree [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] Strongly Agree

6. If I had a problem using the computer, I could solve it one way or another.
   Strongly Disagree [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] Strongly Agree

7. I would prefer to learn new computer software packages on my own.
   Strongly Disagree [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] Strongly Agree
COMPUTER AWARENESS

Mark the circle on the line below each statement that most closely indicates your level of awareness of computers. I am able to

1. discuss strengths and weaknesses of various software packages.

Extremely Low  
Extremely High

2. identify the basic parts of a computer and their functions.

Extremely Low  
Extremely High

3. elaborate on various computer applications in society.

Extremely Low  
Extremely High

4. elaborate on the social and economic impact of computers.

Extremely Low  
Extremely High

5. discuss the history of computers.

Extremely Low  
Extremely High
WHAT DO I KNOW?

Multiple choice—mark the answer that you think is most correct for each the following statements:

1. For most college students the most difficult year is
   - a. freshman year
   - b. sophomore year
   - c. junior year
   - d. senior year

2. A liberal arts education will teach you
   - a. everything you need to know
   - b. how to repair a car engine
   - c. how to learn
   - d. everything you need to know in your major area

3. The mind is like a
   - a. road map
   - b. muscle
   - c. tool
   - d. book
4. Knowledge builds upon
   ☐ a. human nature
   ☐ b. organized ideas
   ☐ c. knowledge
   ☐ d. habits

5. The exclusive study of one specific field
   ☐ a. clarifies the understanding of reality
   ☐ b. distorts the understanding of reality
   ☐ c. puts everything into context
   ☐ d. makes life more manageable

6. A liberal arts education can help you to be a better
   ☐ a. teacher
   ☐ b. husband or wife
   ☐ c. friend
   ☐ d. all of the above

7. A liberal arts education can contribute to making you
   ☐ a. smarter
   ☐ b. less lonely
   ☐ c. happier
   ☐ d. all of the above
8. Good judgment depends upon
   ☐ a. a thoughtful and extensive knowledge of one area of study
   ☐ b. the authority of parents, peers, and professors
   ☐ c. a thoughtful and extensive knowledge of many areas of study
   ☐ d. job-specific training

9. Someone studying to be a doctor should study the following
   ☐ a. biology
   ☐ b. computer programming
   ☐ c. literature
   ☐ d. all of the above
   ☐ e. none of the above
Instructions – Computer, No Strategies Group

The button on this page will take you to an article that is about 3½ pages or 2,300 words in length. We would like you to read and learn from the text. That is, as you read the text, process it as you would any other text that you were reading and studying for class.

Instructions – Computer, Strategies Group

The button on this page will take you to an article that is about 3½ pages or 2,300 words in length. We would like you to read and learn from the text. That is, as you read the text, process it as you would any other text that you were reading and studying for class. The "Track Changes" feature of Word has been enabled in this text. Please use the underlining, highlighting, and note writing features as you read and process this text. That is, try to process this text as if it was printed on paper and you were reading it with pencil/pen and/or highlighter in hand.

Instructions – Paper, Strategies Group

We would now like you to read an article that is about 3½ pages or 2,300 words in length. We would like you to read and learn from the text. That is, as you read the text, process it as you would any other text that you were reading and studying for class. You may use any tools (e.g., highlighter, pen, pencil) that you would normally use in the reading and studying process. Raise your hand and the text will be given to you.

STOP. Do not continue until you have finished reading the text. When you have finished reading, give the text to the researcher and click on the button below to finish the study.

Instructions – Paper, No Strategies Group

We would now like you to read an article that is about 3½ pages or 2,300 words in length. We would like you to read and learn from the text. That is, as you read the text, process it as you would any other text that you were reading and studying for class. Please do not mark or write on the text paper. Raise your hand and the text will be given to you.

STOP. Do not continue until you have finished reading the text. When you have finished reading, give the text to the researcher and click on the button below to finish the study.
On the Purpose of a Liberal Arts Education
Robert Harris

When they first arrive at college, many students are surprised at the general education classes they must take in order to graduate. They wonder why someone who wants to be an accountant or psychologist or television producer should study subjects that have nothing directly to do with those fields. And that is a reasonable question—Why should you study history, literature, philosophy, music, art, or any other subject outside of your major? Why should you study any subject that does not help to train you for a job? Why should you study computer programming when you will never write a program? Why study logic when all you want to do is teach first grade or be a church organist? In answer to this question, let’s look at some of the benefits a liberal arts education and its accompanying widespread knowledge will give you.

A liberal arts education teaches you how to think. You will develop strength of mind and an ordered intellect. The mind is like a muscle; exercise makes it stronger and more able to grasp ideas and do intellectual work. Exercising the mind in one area—whether literature or sociology or accounting—will strengthen it for learning in other areas as well. What at first was so difficult—the habits of attention and concentration, the ability to follow arguments, and the ability to distinguish the important from the trivial and to grasp new concepts—all these become easier as the mind is exercised and enlarged by varied study. You will also learn that thinking has its own grammar, its own orderly structure, and set of rules for good use. Many subjects help the student to develop an ordered mind, and each subject contributes in a slightly different way. A careful study of computer programming or mathematics or music or logic or good poetry—or all of these—will irresistibly demonstrate the structure of thought and knowledge and intellectual movement, and will create the habit of organized thinking and of rational analysis. Once you develop good thinking habits, you will be able to perform better in any job. After your class in programming or poetry you may never write another line of code or verse, but you will be a better husband or wife or preacher or businessman or psychologist, because you will take with you the knowledge of organized solutions, of hierarchical procedures, of rational sequence that can be applied to any endeavor.

You will be able to think for yourself. The diverse body of knowledge you will gain from a liberal arts education, together with the tools of examination and analysis that you will learn to use, will enable you to develop your own opinions, attitudes, values, and beliefs, based not upon the authority of parents, peers, or professors, and not upon ignorance, whim, or prejudice, but upon your own worthy apprehension, examination, and evaluation of argument and evidence. You will develop an active engagement with knowledge, and not be just the passive recipient of a hundred boring facts. Your diverse studies will permit you to see the relations between ideas and philosophies and subject areas and to put each in its appropriate position. Good judgment, like wisdom, depends upon a thoughtful and rather extensive acquaintance with many areas of study. And good judgment requires the ability to think independently, in the face of pressures, distortions, and overemphasized truths. Advertisers and politicians rely on a half-educated public, on people who know little outside of their own specialty, because such people are easy to
deceive with so-called experts, impressive technical or sociological jargon, and an effective set of logical and psychological tricks. Thus, while a liberal arts education may not teach you how to take out an appendix or sue your neighbor, it will teach you how to think, which is to say, it will teach you how to live. And this benefit alone makes such an education more practical and useful than any job-specific training ever could.

The world becomes understandable. A thorough knowledge of a wide range of events, philosophies, procedures, and possibilities makes the phenomena of life appear coherent and understandable. No longer will unexpected or strange things be merely dazzling or confusing. How sad it is to see an uneducated mind or a mind educated in only one discipline completely overwhelmed by a simple phenomenon. How often have we all heard someone say, “I have no idea what this book is talking about” or “I just can’t understand why anyone would do such a thing.” A wide-ranging education, covering everything from biology to history to human nature, will provide many tools for understanding.

A liberal arts education teaches you how to learn. College provides a telescope, not an open and closed book. Your real education at college will not consist merely of acquiring a giant pile of facts while you are here; it will be in the skill of learning itself. No institution however great, no faculty however adept, can teach you in four years everything you need to know either now or in the future. But by teaching you how to learn and how to organize ideas, the liberal arts institution will enable you to understand new material more easily, to learn faster and more thoroughly and permanently.

The more you learn, the more you can learn. Knowledge builds upon knowledge. When you learn something, your brain remembers how you learned it and sets up new pathways, and if necessary, new categories, to make future learning faster. The strategies and habits you develop also help you learn more easily. And just as importantly, good learning habits can be transferred from one subject to another. When a basketball player lifts weights or plays handball in preparation for basketball, no one asks, “What good is weightlifting or handball for a basketball player?” because it is clear that these exercises build the muscles, reflexes, and coordination that can be transferred to basketball—building them perhaps better than endless hours of basketball practice would. The same is true of the mind. Exercise in various areas builds brainpower for whatever endeavor you plan to pursue.

Old knowledge clarifies new knowledge. The general knowledge supplied by a liberal arts education will help you learn new subjects by one of the most common methods of learning—analogy. As George Herbert noted, people are best taught by using something they are familiar with, something they already understand, to explain something new and unfamiliar. The more you know and are familiar with, the more you can know, faster and more easily. Many times the mind will create its own analogies, almost unconsciously, to teach itself about the unfamiliar by means of the familiar. It can be said then, that the liberal arts education creates an improvement of perception and understanding. (This process explains why the freshman year of college is often so difficult—students come with such a poverty of intellectual abilities and knowledge that learning anything is very difficult. After a year of struggle, however, an informational
base has been created which makes further learning easier. The brain has come up to speed and has been given something to work with.)

General knowledge enhances creativity. Knowledge of many subject areas provides a cross fertilization of ideas, a fullness of mind that produces new ideas and better understanding. Those sudden realizations, those strokes of genius, those solutions seemingly out of nowhere, are really almost always the product of the mind working unconsciously on a problem and using materials stored up through long study and conscious thought. The greater storehouse of your knowledge, and the wider its range, the more creative you will be. The interactions of diversified knowledge are so subtle and so sophisticated that their results cannot be predicted. When Benjamin Franklin flew a kite into a storm to investigate the properties of electricity, he did not foresee the wonderful inventions that future students of his discoveries would produce—the washing machines, microwave ovens, computers, radar installations, electric blankets, or television sets. Nor did many of the inventors of these devices foresee them while they studied Franklin’s work.

A liberal arts education allows you to see things whole. A general education supplies a context for all knowledge and especially for one’s chosen area. Every field gives only a partial view of knowledge of things and of man, and, as John Henry Newman has noted, an exclusive or overemphasis on one field of study distorts the understanding of reality. As one armchair philosopher has said, “When the only tool you have is a hammer, you tend to see every problem as a nail.” All knowledge is one, a unified wholeness, and every field of study is but a piece or an angle or a way of partitioning this knowledge. Thus, to see how one’s chosen area fits into the whole, to see the context of one’s study, a general, liberal education is not merely desirable, but necessary.

A well-rounded education, a study of the whole range of knowledge, produces an intellectual panorama, a map of the universe, which shows the relative disposition of things and ideas. Such a systematic view of reality provides an understanding of hierarchies and relationships—which things are more valuable or important than others, how one thing is dependent on another, and what is associated with or caused by something else. As abstract as this benefit may sound, it is just this orientation that will give you a stable foundation for a sane and orderly life. Many people waste their lives in endless confusion and frustration because they have no context for any event or decision or thought they might encounter.

Life itself is a whole, not divided into majors. Most jobs, most endeavors, really require more knowledge than that of one field. We suffer every day from the consequences of not recognizing this fact. The psychologist who would fully understand the variety of mental problems his patients may suffer will need a wide-ranging knowledge if he is to recognize that some problems are biological, some are spiritual, some are the product of environment, and so on. If he never studies biology, theology, or sociology, how will he be able to treat his patients well? Likewise, the doctor who believes that a knowledge of cell biology and pharmacology and diagnosis will be all-sufficient in his practice will help very few patients unless he also realizes that more than
eighty percent of the typical doctor’s patients need emotional attention either in addition
to or instead of physical treatment. The doctor who listens, and who is educated enough
to understand, will be the successful one. A doctor who has studied history or literature
will be a better doctor than one who has instead read a few extra medical books. The
preacher, who would produce effective, understandable, memorable sermons that will
reach his flock, will need a thorough knowledge of English, composition and logic, that
he might preach in an orderly, clear, rational manner.

A liberal arts education enhances wisdom and faith. General knowledge will plant
the seeds of wisdom. It will help you see and feel your defects and to change yourself, to
be a better citizen, spouse, human being. Wisdom is seeing life whole—meaning that
every realm of knowledge must be consulted to discover a full truth. Knowledge leads to
wise action, to the service of God and to an understanding of human nature. General
knowledge is an ally of faith. All truth is God’s truth; why should we ignore or deprecate
an ally, a part of God’s wholeness of revelation? The more you learn about the creation,
in astronomy, botany, physics, geology, the more you will praise the miracles he has
performed. How can an uneducated man praise God for the wonders of crystallization or
capillary attraction or metamorphosis or quasars or stalactites? General knowledge
provides an active understanding of the gospel and of how it intertwines with human
nature, the desires and needs of the heart, the hunger of the soul, and the questions of the
mind. The more you learn about man, from history, psychology, sociology, literature, the
more you will see the penetrating insights and the exact identifications the bible contains.

A liberal arts education makes you a better teacher. But, you say, I’m not going to
be a teacher. To which I say, yes you are. You may not be a school teacher, but you
might be a preacher, a journalist, social worker, supervisor, lawyer, or missionary. Each
of these roles is essentially that of a teacher. But more than this, you will almost certainly
be someone’s friend, husband or wife and probably a parent. As friend, spouse, and
parent you will be a teacher, sharing your life’s knowledge and understanding with
another daily and intimately. In fact, any time two human beings get together and open
their mouths, teaching and learning are going on. Attitudes, perceptions, understandings,
generalizations, reasons, information—all these are revealed if not discussed. It should be
your desire to make the quality, richness, and truth of your teaching as great as possible.

A liberal arts education will contribute to your happiness. A cultivated mind
enjoys itself and the arts. The extensive but increasingly neglected culture of western
civilization provides endless material for pleasure and improvement. A deep appreciation
of painting or sculpture or literature, of symbolism, wit, figurative language, historical
allusion, character and personality, the True and the Beautiful, this is open to the mind
that can understand and enjoy it. Knowledge makes you smarter and smarter is happier.
Recent research has demonstrated that contrary to previous ideas, intelligence can
actually increase through study and learning. Educated and intelligent people have,
statistically, happier marriages, less loneliness, lower rates of depression and mental
illness, and a higher reported degree of satisfaction with life.

STRATEGY USE

Below you will find a list of some of the study tools or strategies that have been identified by specialists as aids in the reading and processing of text. Consider those times that you have been asked to read printed text and learn from it (e.g., studying biology, history, etc.). Then indicate the regularity with which you would typically use each of the following techniques in the studying process.

1. underlining important sentences

2. underlining important words

3. highlighting important sentences

4. highlighting important words

5. skimming or scanning the text before reading

6. reading only the first and last sentences of paragraphs

7. writing notes in the margins

8. outlining the text

9. following cues in the margin (e.g., stop signs, arrows)

Submit Form
WHAT DO I KNOW?

Multiple choice—mark the answer that you think is most correct for each the following statements:

1. For most college students the most difficult year is
   - a. freshman year
   - b. sophomore year
   - c. junior year
   - d. senior year

2. A liberal arts education will teach you
   - a. everything you need to know
   - b. how to repair a car engine
   - c. how to learn
   - d. everything you need to know in your major area

3. The mind is like a
   - a. road map
   - b. muscle
   - c. tool
   - d. book
4. Knowledge builds upon
   - a. human nature
   - b. organized ideas
   - c. knowledge
   - d. habits

5. The exclusive study of one specific field
   - a. clarifies the understanding of reality
   - b. distorts the understanding of reality
   - c. puts everything into context
   - d. makes life more manageable

6. A liberal arts education can help you to be a better
   - a. teacher
   - b. husband or wife
   - c. friend
   - d. all of the above

7. A liberal arts education can contribute to making you
   - a. smarter
   - b. less lonely
   - c. happier
   - d. all of the above
8. Good judgment depends upon
   - a. a thoughtful and extensive knowledge of one area of study
   - b. the authority of parents, peers, and professors
   - c. a thoughtful and extensive knowledge of many areas of study
   - d. job-specific training

9. Someone studying to be a doctor should study the following
   - a. biology
   - b. computer programming
   - c. literature
   - d. all of the above
   - e. none of the above
APPENDIX C

SCRIPT TO PARTICIPANTS
**Initial Session**

Good Morning/Afternoon/Evening

I am Theresa Holleran, a fulltime faculty member here at Ohio Dominican. I teach primarily Computer Science courses.

Your teacher has volunteered you for participation in a research project and has agreed to give you extra credit points for your participation.

This research project may be beneficial in clarifying how the background and ability of students, like yourself, may influence how computers, especially Web-based materials, are utilized in classroom instruction.

I am asking for your serious participation in this project, which will involve the completion of eight online forms and the reading of a short (2,300 words) nonfiction article. The eight online forms will be presented on the screen one at a time. After you have completed filling in each form you will hit the Submit button at the bottom of the page. I would ask you to proceed through the pages in the order specified by following the buttons.

This project will take you about 45 minutes to complete.

Before we begin, are there any students here under the age of 18? You may be excused from this project, but will be awarded the specified extra credit points.

I would now ask you to turn on the computer if it is not already on, open up Internet Explorer, type in the URL  http://odweb.ohiodominican.edu/holleran/research1

Use your Ohio Dominican userid and password to log in to the project, then click on the Research Project button.

The first page of this project is an Informed Consent form. After you have read it, indicate your preference to participate or not, and type in your first and last name in the Signature box. After you finish this project your name will not be attached to data collected. The researchers are interested only in the grouped effects of this study; thus, there is no desire to identify individual participants in the reporting of findings.

Follow the links for the rest of the project.

**Posttest2 (four to six weeks after the intial session)**

Good Morning/Afternoon/Evening

About two weeks ago, you participated in a research project with me. Today I am asking you to complete a short questionnaire related to that project.

On the top of your paper please print your fullname. Your name will be used to link these responses to your previous responses. Your name will not be saved in the database or reported in any of the results of this study.
Group Numeric (1 - 4) 1=CN; 2=CS; 3=PS; 4=PN
Age Numeric
Sex 1 Male  
   2 Female
Major
1 Accounting  
2 Art  
3 Biology  
4 Business Administration  
5 Business Communication  
6 Chemistry  
7 Communication  
8 Computer Science  
9 Criminal Justice  
10 Cross-Disciplinary Studies  
11 Early Childhood Education  
12 Economics  
13 English  
14 History  
15 Information Management  
16 Information Systems  
17 International Business  
18 Intervention Specialist  
19 Mathematics  
20 Middle Childhood Education  
21 Philosophy  
22 Political Science  
23 Psychology  
24 Public Relations  
25 Secondary Education  
26 Social Justice  
27 Social Work  
28 Sociology  
29 TESOL  
30 Theology  
31 Visual Communication  
32 Undecided  
33 Other
Ethnicity
1 Hispanic  
2 African American  
3 Caucasian  
4 Asian/Pacific Islands  
5 Native American  
6 Mixed  
7 Other
Class
1 Freshman  
2 Sophomore  
3 Junior  
4 Senior  
0 Other
Hours Numeric
Computer Use Choices
5 Daily  
4 4-6 times a week  
3 2-3 times a week  
2 Once a week  
1 Less than once a week  
0 Never
Training 1 Yes  
   2 No
Webpage 1 Yes  
   2 No
Gather Never (1) – Always (9)
Strategy Use Choices
5 Always  
4 Almost always  
3 Frequently  
2 Seldom  
1 Almost never  
0 Never