The Effects of Age, Computer Self-Efficacy, and the Design of Web-Based Training on Computer Task Performance

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ABSTRACT

By the year 2020, it is projected that 30% of the United States population will be comprised of people age 65 and older (Administration on Aging, 2004). Individuals over age 65 will continue to constitute a larger proportion of the total population because people are living longer and healthier lives. With older adults living longer, this senior population leads very active lives and often has great interest in modern technology such as the Internet (Nielsen, 2002). Given the use of computers in the workplace and homes and the increase in the number of older adults in the next 20 years, the use of computers by older adults is a significant issue that should be addressed (Czaja, 1996).

Computer tasks involve cognitive skills that may be challenging for older adults. Most of the literature suggests that cognitive skills decline as individuals age **(**Baddeley, 1981; Foos, 1989; Salthouse, 1996; Welford, 1985). Decrements in working memory could place older adults at a disadvantage when performing computer-interactive tasks. To increase the success of older workers' performance with computer technology, web-based training programs designed to accommodate age-related cognitive declines may be an effective avenue to deliver computer training to younger and older adults. The objectives of this study were to explore computer self-efficacy differences between younger adults (18-24 years old) and older adults (65 and older) and to determine if the design of a web-based training system affects individual performance when completing a computer task.

Four hypotheses were tested in this study: older adult-centered web-based training program would yield better performance for both younger and older adults; older adults would have lower computer self-efficacy than younger adults; participants with higher computer self-efficacy would perform better on a computer task; and participants with higher usability ratings would perform better on the computer task. Results of the study did not directly support any of the hypotheses. However, age-related differences were evident in training time, task completion time, performance score, and usability ratings. The older adult participants had longer training and task completion times, lower performance scores, and higher usability ratings. Results were discussed in terms of limitations and implications of older-adult centered training programs.

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DEDICATION

I would like to dedicate this thesis to my parents who have always encouraged my sister and me to work hard, be persistent, and never give up. The two of them have made many sacrifices to ensure that their children was provided the best of everything. Their unconditional love and support has inspired me to accomplish many great things I never imagined. I thank them for just being great parents, remarkable role models, and now, good friends. I am truly blessed to be the daughter of two great people. No matter how far I make it in life, my love and admiration for my parents will never change. Thank you for believing in me and showing me that *I can do all things through Christ who strengthens me (Philippians 4:13).*

Love,
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CHAPTER 1. INTRODUCTION

According to the Administration on Aging (2004), in 1900, 4.1% of the United States population was comprised of people age 65 or older. In 2003, people age 65 and over represented 12.7% of the United States population (Administration on Aging, 2004) which means this older adult population has increased by 300% since 1900. In the next decade, the population of seniors will continue to grow. By the year 2020, people age 65 and older will comprise of more than 20% of the population in the United States. Figure 1 shows the increasing elderly population over time.

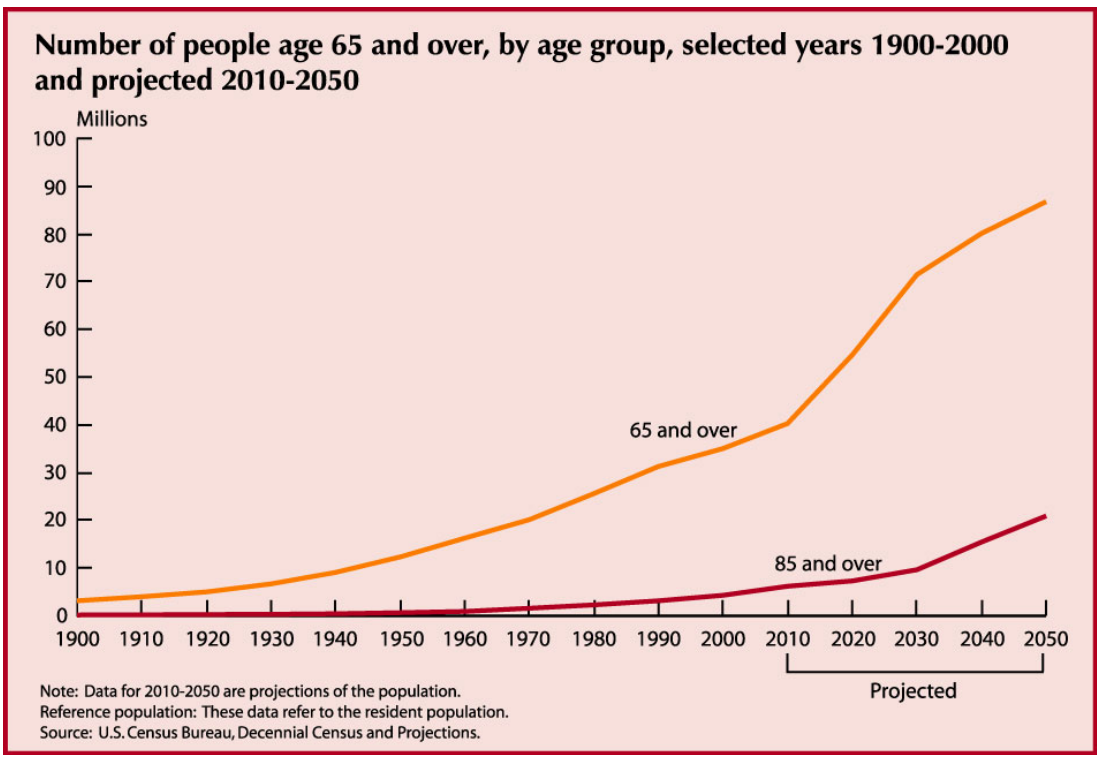

Figure 1. Total number of people in millions age 65 and older, from the year 1900 – 2050 (Administration on Aging, 2004).

Seniors over age 65 will continue to constitute a larger proportion of the total population because people are living longer and healthier lives. Older adults are living longer because of better health care and medication, declines in the incidence of diseases, and new technologies (Clark and Quinn, 2002). This demographic shift in older adults suggests that seniors can be one of the fastest growing groups on the Internet. In fact, 8 million Americans age 65 or older, 22% of the elderly population, use the Internet (Fox, 2004). This percentage of seniors using the Internet has increased to 47% between 2000 and 2004. Older adults are using the Internet as an alternative method to communicate and stay informed. This senior population is using the World Wide Web for research, news, tracking investments, researching medication and medical conditions, and to shop and bank online.

Greater life expectancy implies that older adults may remain in the workforce longer and save more funding to accomplish the same level of retirement income in relation to their pre-retirement earnings (Clark et al., 2002). According to the U.S. Census Bureau (Smith, 2003), 28% of workers in the civilian labor force are 65 years old and over. As the population ages, the development of technology is continuously increasing and the nature of work is changing. Computers are becoming very common in the workplace (Charness, Kelly, Bosman, and Mottram, 2001). Studies have shown (Charness and Bosman, 1990; Czaja, 1996) that older adults can learn to use computer technology, but older adults have more difficulty than younger adults in acquiring computer skills. On almost all tasks, older adults tend to learn more slowly than younger adults. For older adults, slower learning is evident when older adults try to master tasks related to new technology such as using the Internet and automated teller machines (ATMs) (Fisher, 2001). Because web-based computer training is related to new technology, this type of training may be problematic for older adults. In addition to the change in technology, computer self-efficacy and fear of automation hinders seniors from mastering tasks as fast as their younger counterparts (Cassidy and Eachus, 1999).

1.1. Problem statement

Given the use of computers in the workplace and the number of older workers that will be in the workplace in the coming years, the use of computers by older workers is a significant issue that must be addressed by employers and their organizations (Czaja, 1996). The skill acquisition literature indicates that older people have more difficulty than younger people in acquiring new skills and they achieve lower levels of performance (Charness and Bosman, 1990). Computer tasks involve cognitive skills that may be problematic for older adults. For example, computer tasks place a high demand on working memory (Hockey, Briner, Tattersal, and Wiethoff, 1989). Decrements in working memory could place older adults at a disadvantage when performing computer-interactive tasks. To lessen this drawback, older adults should learn new concepts and apply new meaning to familiar concepts. Although other training alternatives (classroom training, simulator training) exist to ensure the success of older workers with computer technology, this study will focus on web-based training (WBT), a type of training many companies are moving towards in the workplace (Goldstein and Ford, 2002).

Because of several limitations with the traditional classroom and simulator training methods, companies are gradually shifting away from these traditional approaches. These limitations include: (1) cost of training, (2) meeting trainees' needs, (3) delivery time of training, and (4) skill practice (Goldstein and Ford, 2002). Traditional classroom and simulation training methods are often very expensive for companies. Many companies have to incur the cost of travel for transporting the trainees to a remote location for training and transporting trainers to different locations to train the individuals. Additional costs incurred for traditional training approaches include the cost to obtain and maintain simulator equipment. The use of traditional modes of training is not individualized to meet the trainees' needs. The pace and plan of the instruction are set by the trainer and do not accommodate the individual trainees. Traditional training programs are usually scheduled and presented at a certain time. Set schedules force trainees to attend training before or even after training is needed. With scheduled times for training, just-in-time training is difficult to schedule with scheduled classroom instruction. Traditional instructional training can only provide a minimal amount for skilled practice. More individualized training requires multiple trainers. The practice time during the training must be shared among all the trainees attending the training session. Practice is often limited to the examples completed during training. Traditional classroom and simulator training and WBT are all methods used to train individuals; this study explores the effectiveness of web-based computer training.

Current research concludes that cognitive aging contributes to older adults not performing as well as younger adults when trained on new computer skills (e.g. using a database or word-processing, exploring the web, using a medical device). However, limited research is available on how to design WBT programs that accommodate cognitive degradation common in some older adults and help older adults perform as well as their younger counterparts. The purpose of this study was to develop an older-adult centered (OAC) WBT system. An OAC WBT program is web-based instruction (WBI) designed to accommodate older adult degradations related to vision and cognition based on guidelines provided by the National Institute on Aging and the National Library of Medicine (2002). Figure 2 displays the model that was used as a guiding framework in this study. Web-based training, age, and computer self-efficacy differences were examined to determine how they impacted younger and older adults' task performance.

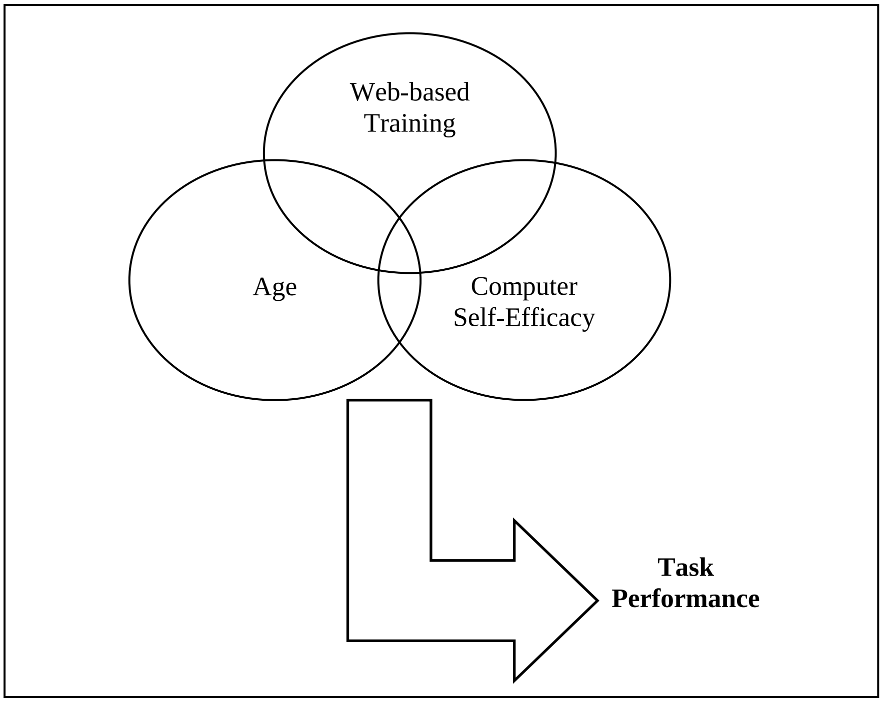

Figure 2. Model of effects of age, computer self-efficacy, and WBT on task performance.

1.2. Research justification

1.2.1. Web-based computer training

In this era of computer technology advances, traditional lecture-styled training is being replaced by computer-assisted learning such as WBT. Web-based training is instruction that is delivered to trainees from remote sites accessed by the Web. This type of training consists of both web courses and web-assisted teaching such as Blackboard. For this research, the focus will be web courses. Computer-assisted learning such as WBT offers the potential to increase an individual's access to new computer skills. Web-based training allows trainees to control their teaching and learn at their own pace (Goldstein and Ford, 2002). Because of web access in the home, work, and public places, trainees have the flexibility to learn from different locations at her/his preferred times. Web-based training can also complicate training design if the user is not considered when designing the training program (Hannafin, Hannafin, Hooper, Rieber, and Kimi, 1996). Because older adults likely have not had as much exposure to technology as the younger adult population, many designers do not consider these older adults as potential users of the latest technology (Goldstein and Ford, 2002). Training program designers must recognize older adults as users of WBT and design WBT programs that accommodate cognitive decrements and low computer self-efficacy associated with older adults.

1.2.2. Computer use for older adults

With a demographic shift in age, WBT programs need to be designed taking into account age-related degradations (e.g., working memory, processing speed, cognitive resources). In order to enhance the use of computer technology for older adults, it is essential for designers to conceptualize older adults as active users of technology. Designers should position themselves to understand the implications of age-related changes in abilities for the design and implementation of technological systems (Charness, Kelly, Bosman, and Mottram, 2001). Older adults have a difficult time learning new technology (Fisher, 2001). Customizing an effective training program for older adult workers can make training more effective, improve the worker's training retention and performance on the job, and allow older adults to take advantage of what new technology has to offer (Fisher, 2001). Implications that can be designed into WBT can help older adults reduce the time to learn a task. This research can add to the existing documentation on better approaches to ensure that older adults can use new technology (Fisher, 2001). Also, consideration must be given to the literature limitations as discussed in the next section.

1.2.3. Lack of Empirical Evidence

One limitation with previous research related to aging and training is the length of the studies. Many of the studies on working memory **(**Baddeley, 1981; Foos, 1989; Salthouse, 1996; Welford, 1985) evaluated two groups, younger adults and older adults. The studies explored working memory by administering reading and math tasks to measure spatial and verbal components of working memory. To fully understand age-related declines to working memory, researchers need to examine long term effects. Several researchers (e.g. Mead, Spaulding, Sit, Meyer, and Walker 1997; Morrell, Park, Mayhorn, and Kelley, 2000; Zandri and Charness, 1989) compared the performance of younger and older adults on specially designed computer tasks. A critical issue in these studies is whether the task is relevant to actual occupational activities and if the results found were applicable to real world conditions.

For many computer-related studies, participants have different levels of computer experience. Individual differences have been a major problem for many age-related studies. Mead and Fisk (1997) reported that their sample of young adults differed substantially from their sample of older adults. The young adults reliably used ATMs and computers more often, read faster, and had greater reading comprehension and working memory capacity. These differences can significantly impact the results related to performance between younger and older adults. To help determine the impact of working memory decline related to age, individual differences should also be measured in the studies.

1.2.4. Research support

This research was intended to assist organizations with the development of computer training programs needed to improve performance of older adults without hindering the performance of younger adults. For example, Wiedenbeck and Zila (1997) found a training intervention to assist older individuals when learning new computer tasks. The researchers examined different training methods on younger and older adults. Older adults benefited most from training that conveyed to them exactly how to complete an activity and was more conceptual on other tasks. They concluded that matching the training approach to the specific task allowed the older adult to perform as well as younger users.

1.3. Research purpose

1.3.1. Primary purpose

The primary objectives of this research were to:

1. Design a web-based computer training program to accommodate age related degradations related to cognitive aging.
2. Investigate if learning a new computer skill affects an individual's computer self-efficacy.
3. Determine if older and younger adults' task performance will differ from the type of web-based computer training received.

1.3.2. Secondary purpose

The secondary purpose of this research was to examine individual differences, specifically computer self-efficacy and gender, to determine if these factors affect an individuals' task performance.

1.4. Research questions

The study was designed to answer the following questions:

1. How does the type of WBT (controlled or OAC) impact task performance?
2. What are computer self-efficacy differences between younger and older adults?
3. How does computer self-efficacy impact task performance?
4. How does usability (content, layout, animation, color, size) of the WBT impact the older and younger adults' task performance?

1.5. Hypotheses

1. For research question one, it was hypothesized that the OAC web-based computer training condition would yield better performance for both younger and older adults. This hypothesis was tested by measuring how the participants performed on the web page computer application task (performance score), the time it took the participant to complete the task, and the number of errors the participant performed while completing the task. The participants who received the OAC web-based computer training were expected to finish the computer application task in the shortest amount of time, and make the least number of errors compared to the individuals who received the controlled WBT.

2. For research question two, it was hypothesized that older adults would have a lower computer self-efficacy score than younger adults. Hypothesis two was tested by using Cassidy and Eachus' (2002) Computer Self-Efficacy (CSE) scale (Appendix A).

3. For research question three, it was hypothesized that the participants with higher computer self-efficacy scores would perform better on the computer application task. Hypothesis three was tested using the CSE scale (Appendix A), the time it took for the

trainee to complete the computer task, the performance score, and the number of errors the participant performed while completing the task. The participants with the higher computer self-efficacy scores were expected to complete the task in the shortest amount of time, have the higher performance scores, and perform the fewest number of errors.

4. For research question four, it was hypothesized that the participants with the higher usability ratings would perform better on the task. Hypothesis four was tested using the subjective usability rating scale (Appendix B) and the time it took for the trainee to complete the computer application task. It was anticipated that the participants who had the higher usability ratings would finish the task in the least amount of time and perform the fewest number of errors.

1.6. Document overview

The remaining body of this paper is divided into five main chapters – the literature review, methodology, results, discussion, and conclusion, respectively. Chapter 2, the literature review, examines the current literature for information relevant to this study. This chapter begins by exploring cognitive aging theories and then applying these theories to computer training for older adults. In the methodology chapter of this paper, the experimental design for the study is explained. The experimental design is followed by a description of the variables and measurements, an overview of the participants, and a description of all of the materials and equipment involved in the study. The methodology chapter is concluded with a detailed description of the procedures and data analysis. Following the methodology chapter, Chapter 4 reports the results from the study. The results are divided into ANOVA, correlation analysis, and content analysis. After the results chapter, the discussion chapter provides a detailed description of the results from the study. The last chapter of this paper is the conclusion chapter. This chapter provides recommendations for designing for older adults, limitations and assumptions of the study, and recommendations for future research.

CHAPTER 2. LITERATURE REVIEW

2.1. Cognitive aging

A number of factors influence cognitive performance and learning. Two known factors are processing speed and cognitive resources. Researchers have concluded that age-related differences are associated with processing speed and cognitive resources. Because processing speed and cognitive resources are closely interdependent in working memory, it is important to know how working memory is altered by aging.

Working memory is defined as a processing resource of limited capacity involved in the preservation of information while simultaneously processing the same or other information (Salthouse, 1996). During processing, information may be lost or processed. If information is processed, the information is converted into a form of response (verbal or spatial) held in working memory, and then stored in long-term memory for use at another time (Baddeley, 1981). Several researchers (Salthouse and Babcock, 1991; Swanson, 1999) suggest that age-related performance of older adults is characterized by the inability to retain information in memory while simultaneously processing other information when compared to younger adults.

The findings about working memory provide several conclusions for older adults and their ability to acquire computer skills. Older adults could be expected to follow simple clear instructions just as well as younger adults. As the demands of performing a computer task become more complex, it is expected that older adults will not perform as well as younger adults (Salthouse, 1996). Because of increased requirements on working memory, older adults would be expected to have more problems performing computer tasks compared to younger adults (Foos, 1989).

2.1.1. Cognitive resources

A frequently cited theory in the cognitive aging literature is that cognitive changes are responsible for declines in memory performance of older adults (Salthouse, 1996). For example, when either complex or large quantities of information are presented to older adults, the available processing capacity in older adults becomes overloaded, causing the storage of information to be less efficient than younger adults. This is due to fewer resources available for older adults (Foos, 1989). Fewer resources make it difficult for older adults to process new information or store already processed information.

The cognitive aging theory supports the concept that age differences in cognitive abilities can be attributed to the decline of process resources in older adults (Jones and Bayen, 1998). These process resources include both attentional capacity and working memory. Older adults perform worse than younger adults on tasks measuring working memory and attentional capacity (Dobbs and Rule, 1989; Salthouse and Babcock, 1991). Cognitive performance is influenced by an individual's cognitive workload (Kirschner, 2002). An individual's cognitive workload is stimulated by the task the individual has to perform. Human performance is degraded when an individual's available resources are not sufficient to perform mental operations necessary to complete a task (Tomporowski, 2003). In cognitive performance, age-related differences are greater for complex tasks and tasks that place higher demands on limited resources (Cerella, Poon, and Williams, 1980; Salthouse, Mitchel, Skovronek, and Babcock, 1989). Age-related differences in learning and recall are especially obvious if the learning problem is in an unfamiliar cognitive domain and require building new schemas (Welford, 1985). Working with computers frequently represents an unfamiliar cognitive domain for many older adults.

Consequently, it is possible that older adults may need more resources to carry out the same processing as their younger counterparts.

2.1.2. Processing speed

Processing speed and capacity are interdependent in working memory. The processing speed theory suggests that the fundamental mechanism that accounts for age-related differences in performance is decreased speed of performing mental operations (Park and Schwarz, 2000). According to Salthouse (1996), the slowing of cognitive processes account for age differences in higher-level cognitive abilities such as spatial abilities and long-term memory. The result of the age difference is a decline in higher-level cognitive abilities and individual performances as individuals age (Salthouse, 1996). Therefore, as individuals age, there is a slowing of brain processing speed.

2.2. Computer training for older adults

Tasks that require the most cognitive processing, such as working memory, seem to make the largest impact on older adults (Sharit and Czaja, 1994). Mead, Spaulding, Sit, and Walker (1997) had young (19-36 years old) and old (65-81 years old) participants conduct web site searches. The older users had the most difficulties with tasks that required three or more clicks. The older users also searched less efficiently than younger users. Most of the difficulties encountered by the older users seemed directly related to memory limitations.

Mykityshyn, Fisk, and Rogers (2002) examined age-related differences in training individuals how to use a home medical device (blood glucose monitor). Two types of training methods (instruction and video) and age groups (younger adults ages 17-24 years and older adults ages 65-75 years) were included in the study. Older adults had poorer performance than younger adults possibly due to age-related differences in working memory. In a study training older adults how to use a text-editing system, Czaja, Hammond, Blascovich, and Swede (1989) found that older adults were less successful than their younger counterparts in performing the text-editing task. Czaja, Hammond, Blascovich, and Swede (1989) concluded that there was a need to develop more effective training strategies to teach older adult learners computer technologies. Comparative results were also found in a study training older adults to use ELDERCOMM, an electronic bulletin board system (Morrell, Park, Mayhorne, and Kelly, 2000). The young-old group (ages 60-74 years) outperformed the old-old group (ages 75 years and older) in their ability to acquire and retain computer skills.

Zandri and Charness (1989) examined the influence of training method on learning to use a calendar and notepad system. The sample consisted of younger (ages 20-39 years) and older (ages 58-64 years) participants. They found that older adults took twice as much time to proceed through the tutorials than the younger adults. It is likely the older adults took more time because of the unfamiliarity of the computer tasks, which may have required more resources and time to process the new information and pull similar schemata from the long-term memory. Although there was a significant time difference for completing the tasks, the older adults achieved nearly equal levels of performance as the younger participants. These findings suggest that older adults are capable of learning computer skills, but they learn at a slower rate, make more errors, and require more assistance than younger adults.

Previous studies (Mead and Fisk, 1997; Zandri and Charness, 1989) have shown that different training methods are better than others for teaching both young and older adults how to perform computer procedures. Older adults take more time, make more mistakes, and require more assistance than younger adults. Morrell, Park, Mayhorn, and Kelley (2000) explored the effects of age and instructions (explored and elaborated) on teaching older adults to use an electronic bulletin board system. Their findings supported the findings of Charness, Schumann, and Boritz (1992). Specifically, Morrell, Park, Mayhorne, and Kelley (2000) found that "young-old" adults (ages 60-74 years) outperformed "old-old" adults (ages 75 years and older) in their ability to acquire and retain computer skills and simple instructions facilitated computer acquisition in both age groups relative to expanded instructions. It is possible that "old-old" adults might not be able to understand instructions as well as "young-old" adults because of age related declines in cognition. Age discrepancies observed in the performance of computer tasks also may be due to age-related decline in working memory (Baddeley, 1986) and declines in perceptual speed (Salthouse, 1996). Older adults are slower than younger adults when cognitive tasks become more complex or require large amounts of mental processing (Hale, Myerson, and Wagstap, 1987). To help improve the time it takes for older adults to acquire a computer task, WBT programs can be designed to address cognitive issues associated with older adults.

2.3 Web-Based Instruction

2.3.1. Web-Based Instruction

The use of the Internet's World Wide Web (also known as the web) is one of the major advances in technology that is changing the way education is delivered and received by instructors and students, respectively (Case, Bauder, and Simmons, 2001). The web provides the opportunity for WBI. Bannan and Milheim (1997) define WBI as a "hypermedia-based instructional program, which utilizes the attributes and resources of the web to create a meaningful learning environment where learning is fostered and supported." Web-based instruction is a form of "distance education" that uses electronic representations of print or video to educate the learner.

Various formats of WBI are available to teach courses. Web-based instruction is typically divided into three categories (Hall, 1997): text and images, interactivity, and interactive multimedia. Interactivity with WBI engages the learner and provides the learner immediate results of action (e.g. pre-tests, post-tests, and exercises). The third category, interactive multimedia, key features are audio and video. The WBT programs in this study used a combination of the three categories.

When using WBI, two forms of communication involving the instructor and the student are synchronous communication or asynchronous communication (Moore, Cookson, and Donaldson, 1990). Synchronous communication is when both the instructor and learners are concurrently involved in teaching and learning. On the contrary, asynchronous communication occurs when both the instructor and learners are not involved in teaching and learning at the same time. For this study, the focus was on asynchronous communication because the learner was the only individual involved with the teaching and learning. Asynchronous communication and WBI makes education attainable to meet the educational needs of special groups such as single mothers, persons with disabilities, older adults, and individuals who work multiple jobs (Hall, 1997).

2.3.2 Advantages

Using the Internet to deliver WBI offers many advantages (Barnard, 1997; Kirby, 1997). Primary advantages of WBI include the ease of delivering and modifying content, linking capabilities, and the decreased need for technical support (Kirby, 1997). Ease of delivering is important due to the increasing number of people using computers and the web. More people using the web allows more people access to content and information being offered nearly anytime and anywhere. The content being offered can be modified easily by simply rewording the information or changing the web connection. In addition, the ability to link too many sources across different states and countries allows content to be easily accessed and disseminated.

Aside from advantages presenting the content, WBI has many other advantageous features: global accessibility, online resources and support, learner control, convenience, ease of use, cost-effectiveness, and collaborative learning (Bannan and Milheim, 1997). Although the web seems to present infinite possibilities for instruction, there are also limitations of WBI.

2.3.3 Limitations

Limitations attributed to WBI include the potential for lack of non-verbal feedback, minimal interaction between the instructor and learner, and misinterpretation of asynchronous textual communications (Barnard, 1997). Non-verbal behavior can transmit a significant amount of communication during class time (Barnard, 1997). Web-based instruction excludes the use of visual cues, which can be beneficial to the learner. Visual cues are used to emphasize specific information and perspectives. Additionally, a lack of interaction between the instructor and learner can make the learner's educational process feel quite removed to the degree that they feel they are not learning what they should be learning (Barnard, 1997). At the same time, learners can misinterpret or misread information being presented due to a lack of contextual cues (Barnard, 1997). To help strengthen WBI, the usability of WBI should be explored.

2.3.4 Usability

As a result of software designers and developers incorporating principles of human-computer interaction into their work, emphasis on usability has grown in the past fifteen years (Levi and Conrad, 2000; Pavlik, 2000). Some designers suggest that concerns for usability are not truly integrated into the design and development of educational software. When researching web-based computer training, it is important to know what the user likes and dislikes about the WBT. When designing user interfaces for WBT programs, there are many usability characteristics that should be considered (Norman and Draper, 1986; Storey, Phillips, Maczewski and Wang, 2002). First, the important sections of the web page must be visible. The content of the web pages should be formatted and displayed so the users can easily see or access the important sections and navigational aids. Feedback is essential when designing a web page. The user interface must provide appropriate feedback to the users. Finally, the WBT program should be consistent. Consistency includes consistent sequences of actions, consistent labeling of links and buttons, and a consistent navigation format. To make certain these characteristics meet the need of the targeted users, potential users should be involved in the development of the WBT program. In addition to usability considerations, the WBT program should be designed to accommodate degradations in working memory.

2.4. Applying working memory to web-based computer training

According to Hawthorn (2000), reducing the interface demands on an older adults' working memory will decrease the slowing of working memory. Interface demands are elements of the training program interface (e.g. text, screenshots, animation) that require the working memory to process the information being conveyed. To help reduce the interface demands, interfaces should emphasize simplicity, avoid distractions, and present lists more frequently than paragraphs to display information (Hawthorn, 2000). Researchers have developed recommendations for characteristic of training methods to help individuals, especially older adults, learn. Hollis-Sawyer and Sterns (1999) concluded that most older adults, as well as younger adults, benefit from training programs that provide the following characteristics:

1) Provide structure in learning the task

2) Organize the presentation of material

3) Permit active participation in the learning process

4) Provide rapid feedback regarding progress

5) Recognize pacing preferences of older trainees

Table 1 displays the research characteristics and conditions the different training programs will incorporate.

Table 1. Research characteristics and conditions.

Characteristics suggested by literature	**Controlled training**	**Older-adult centered training**
Provides structure in learning the task	Training adapted from Faculty Development Institute	Training adapted from Faculty Development Institute
*Organizes the presentation of material	10-14 point text size	14-20 point text size
*Permits active participation in the learning process	None	Videos demonstrate how to complete tasks
Provides rapid feedback regarding progress	Quizzes at end of training provides immediate feedback	Quizzes at end of training provides immediate feedback
Recognize the pacing preferences of older trainees	WBT is self-paced	WBT is self-paced

*Denotes major difference between trainings

The major differences between the training approaches are the text size and the task demonstrations. The controlled training text size is smaller than the text in the OAC training. In addition, the controlled training uses screenshots (pictures of the screen) to demonstrate each task, where as the OAC training uses videos to demonstrate how to complete the tasks. The videos allow the participants to have an active participation in the learning process.

2.5. Individual differences

2.5.1. Computer self-efficacy

Self-efficacy beliefs determine how people feel, think, behave, and motivate themselves (Bandura, 1994). Computer self-efficacy can be defined as beliefs that determine how people feel, think, motivate themselves and behave interacting with computers. Based on reliability and validity, the CSE scale was appropriate for this study. The scale's internal validity estimate was alpha = 0.97 and construct validity included significant and positive correlation from self-reported measures of computer experience and the number of computer packages used. Computer self-efficacy has been recognized as a factor which may contribute to the success of mastering computer tasks and the frequency with which individuals use computers (Cassidy and Eachus, 1999). The human computer interface is becoming increasingly more intuitive, but for inexperienced computer users, interfaces still pose challenges. The Compeau and Higgins (1995) study concluded that individuals with higher computer self-efficacy used and enjoyed using computers more. Computer experience has also been associated with determining the levels of computer self-efficacy. In a study with a sample of 133 undergraduates, Hill, Ahmit, and Mann (1987) found a significant positive correlation between previous computer experience and computer self-efficacy.

2.5.2. Computer experience

There have been several approaches to assess computer experience. Gardner, Dukes, and Discenza (1993) used frequency of computer use to indicate computer experience. To determine frequency of use, Gardner et al. (1993) asked participants to check when computers were used in the course of a day. There are many meanings that can be associated with "computer use".

Other studies have used individual characteristics such as computer ownership, weeks or years of use of a computer, and whether or not an individual has taken computer classes to measure computer experience (Loyd and Gressard, 1984). Some studies have combined the aforementioned approaches to assess computer experience (Lee, 1986).

Potosky and Bobko (1998) concluded that a general measure of computer experience should assess both the use of computers for general task performance as well as knowledge about computers. Based on reliability and validity, a relevant scale for this study is the Computer Understanding and Experience (CUE) Scale. An adapted version of the CUE scale was used in the demographic questionnaire (Appendix C). The scale's internal reliability estimate was alpha = 0.93 and the support of construct validity included significantly and positively correlated data from the scale with individual self ratings and experience (Potosky and Bobko, 1998).

2.5.3. Gender

Chou (2001) concluded that gender was proposed as a variable that moderates the effects of training method and computer attitudes. As a result of Chou's research on gender effects, he hypothesized that males will generally score higher on computer learning performance measures and score lower on computer anxiety measures. Cassidy and Eachus (2002) revealed similar results in their study on computer self-efficacy. Their study showed that males had significantly higher computer self-efficacy.

CHAPTER 3. METHOD

3.1. Experimental design

This study used a 2 x 2 x 2 between-subjects design. The main factors were training type, age, and gender. The two levels of training type were controlled and OAC. The two levels of age were younger adults and older adults. Female and male were the two levels of gender. Detailed information about the levels and types of these factors is provided in Table 2.

Table 2. Factor levels and types.

Factor Name	**Levels**	**Type**
Training type (A)	Controlled and Older-Adult Centered	Between-Subject, Fixed Effects
Age (B)	Young and Old	Between-Subject, Fixed Effects
Gender (C)	Female and male	Between-Subject, Fixed Effects
Subjects (S)	$S_1 \ldots S_{32}$	Between-Subject, Random Effects

Table 3 illustrates the data matrix used for this study.

Table 3. Data matrix.

		Training Type (A)	
		Controlled	Older-Adult Centered
		Age (B)	
		Younger Adults	Older Adults
Gender (C)	Males	S_{1} S_{2} S_{3} S_{4}	S_{17} S_{18} S_{19} S_{20}
	Females	S_{5} S_{6} S_{7} S_{8}	S_{21} S_{22} S_{23} S_{24}
	Males	S_{9} S_{10} S_{11} S_{12}	S_{25} S_{26} S_{27} S_{28}
	Females	S_{13} S_{14} S_{15} S_{16}	S_{29} S_{30} S_{24} S_{32}

3.1.1. Independent variables

<u>Training type</u>

Training type was a between subject factor. The two levels of training type were controlled and OAC. Both groups of individuals were taught how to create a web page in Macromedia® Dreamweaver. The controlled training was a WBT program constructed from the traditional instructional training used by the Faculty Development Institute (FDI) at Virginia Tech (Schwartz, 2003). The OAC training program was also a WBT program developed from FDI (Schwartz, 2003). In addition, the OAC website incorporated characteristics suggested by the research literature (e.g., rapid feedback, sensitivity to pacing, active participation) to effectively teach older adults (Hollis-Sawyer and Sterns, 1999).

Age

Age was a between-subject factor. The two levels of age were younger adults and older adults. The younger adult age group consisted of adults aged 18-24 years old; the older adult age group was made up of adults aged 60 years old and older. Upon reviewing the literature, there was a lack of consistency across the studies when defining young versus older users. Mead, Spaulding, Sit, and Walker (1997), Zandri and Charness (1989), and Morrell, Park, Mayhorn, and Kelley (2000) conducted three different studies where they defined older adults in three different ways: adults over 55, adults over 60, and adults over 65. Age 60 years and older was selected to remain consistent with the guidelines designed for older adults by the National Institute on Aging and the National Library of Medicine (2002). The National Institute on Aging and the National Library of Medicine identify older adults as 60 years and older.

Gender

Gender was a between-subject factor. The two levels of gender were female and male. Previous studies (Chou, 2001; Cassidy and Eachus, 2002) have documented significant gender differences in computer learning performance and computer self-efficacy. Therefore, this study explored gender differences.

3.1.2. Dependent variables

Training time

Training time was the time it took for the participant to complete the WBT program. Each participant was timed as they went through the training program using an embedded timer in the Camtasia Studio 2.0. An embedded timer allowed the participant's activity to be timed without the visual presence of a timer. The timing began when the participant clicked on the log-in icon on the welcome screen of the WBT program. Timing ended when the participant clicked on the log-out icon located on each page of the WBT program.

Performance

Performance was a dependent measure used to determine the effect of the fixed effects. The participant's performance was measured by their knowledge assessment score, task completion time, performance score, and web page score.

Knowledge

A knowledge assessment (Appendix D) was administered to measure the understanding of the concepts found in the WBT. The knowledge assessment consisted of eight short answer questions. Five of the eight knowledge assessment questions were included in the demographics questionnaire as pre-knowledge assessment questions (Appendix E) to determine the participant's knowledge about creating web pages in Macromedia® Dreamweaver prior to the study. The knowledge assessments were scored by an undergraduate student not associated with the study using idea units (Mayer and Chandler, 2001) to control the researcher's bias and preconceived notions of what the participants learned during the training program. Each correct idea unit received one point and incorrect idea units received zero points. The knowledge score was calculated summing the number of correct idea units.

Task completion time

Task completion time was the time it took the participant to complete the computer task. The researcher timed the participant using a timer embedded in the Camtasia 2.0. Timing began when the participants opened Macromedia® Dreamweaver software and ended when the participant clicked *print* to print their web page.

Performance error

Performance error was the number of errors the participant made while completing the computer task. Errors included not completing the 12 required tasks and using the wrong command button to complete a subtask. The errors were documented via paper and pencil by viewing the recording of the participants' movement, clicks, and exploration recorded by Camtasia Studio 2.0.

Web page design

Web page design was evaluated by an expert web page developer. The expert web page developer is a doctoral student in Curriculum and Instruction in Career and Technical Education in the Department of Teaching and Learning at Virginia Tech. Each participant's web page was evaluated on appearance, structure, and functionality of links (Appendix F).

<u>Subjective usability questionnaire</u>

To test the usability of the WBT program, a subjective usability questionnaire (Appendix B) was administered. The questionnaire consisted of Likert-type ratings and open-ended questions regarding the WBT program information, layout, and satisfaction with the training program. These questions were asked to help determine what the users preferred most about the WBT programs and to help develop WBT programs in the future for a broader audience, both young and old adults.

Computer self-efficacy

Computer self-efficacy was measured by administering the CSE scale adapted from Cassidy and Eachus (2002). The questionnaire consisted of Likert-type ratings. The CSE scale examined computer self-efficacy and the benefits and difficulties people experience when using computers. In addition, six of the 31 questions were administered prior to the study (Appendix E) to determine the participant's computer self-efficacy before completing the training.

3.2. Participants

Participants for this study were recruited from the Virginia Tech and New River Valley Community. Flyers were posted in grocery stores and public libraries in the New River Valley Community and on the Virginia Tech campus to advertise for participants for this study. In addition, an e-mail was sent to the residents of Warm Hearth Village Retirement Community to help recruit older adult volunteers. Participation in the study was limited to individuals who had at least: one year of work experience outside of the home in the past five years, a minimum of one year of computer experience and Internet experience, and no experience creating web pages or using programming languages such as HTML or Java. These criteria were important to this study because it allowed the researcher to find a computer task that was sensitive across age. Without these criteria, it would have been difficult to find a computer task that was not too simple and complex enough for both younger and older adults. One year of computer experience and Internet experience were determined by the mean number of days per week the participant uses the computer and Internet and the mean number of hours per day the participant uses the computer and Internet. The participant's eligibility to participant in the study was determined during the pre-screening phase of the study when the participant completed the demographic questionnaire (Appendix C). All participants received a monetary compensation for their participation in the study.

Thirty-two participants were recruited for this study. The participants were recruited based on the age definition of younger adults (18-24 years old) and older adults (60 years and older). The sample of the participants of this study included six African-Americans, twenty-two European-Americans, three Hispanic-Americans, and one unidentified ethnicity. All of the participants had at least four years of computer and Internet experience. The mean age of the participants was 45 years old (*SD* = 26.45 years). Sixteen participants (eight males and eight females) were young adults between the ages of 18-24 years old. The mean age of the younger group of participants was 19 years old (*SD* = 1.39 years). For the older group, 16 (eight males and eight females) participants were older adults aged 60 years old and older. The mean age of the older adult participants was 71 years old (*SD* = 5.12 years).

Each group (young and old) of participants was randomly assigned to the two levels of training type (control and older-adult centered). Eight younger adults were exposed to the controlled training and the other half of the younger adults were exposed to the OAC training. For the older adults, eight participants were exposed to the controlled training and eight participants were exposed to the OAC training.

3.3. Equipment and Apparatus

3.3.1. Laboratory set-up

The study was conducted in the Macroergonomics and Group Decision Systems Laboratory in the Human Factors Engineering and Ergonomics Center at Virginia Tech. Although the training was web-based and multiple participants could have been tested at one time when more than one computer was available, only one participant was tested at a time. The participant had her/his own computer workstation to complete the study. Throughout the study, the researcher was present in a separate room to monitor the participant and be available to answer general questions (instruction clarity, overview of the study, technical) that were asked throughout the study. An observation glass (two-way mirror) allowed the researcher to monitor the participant from a different room. When questions arose, the participant was instructed to ring a bell for assistance. In addition to being monitored by the researcher, during the application section of the study, the participants' exploration and mouse movement and clicks were recorded using Camtasia Studio 2.0, a full-motion screen software tool.

3.3.2. Computer hardware

In the Macroergonomics and Group Decision Systems Laboratory, a desktop PC, keyboard, and mouse were used to train the participants on how to create a web page in Macromedia® Dreamweaver. This task was selected because it is a "real world" task and tool currently used in industry. In addition, it was unlikely that the participants had experience using this software.

3.3.3. Web-based computer training

The WBT program was designed to teach the participants how to create a web page using Macromedia® Dreamweaver software. Using the Macromedia® Dreamweaver software, web pages tend to be easy to understand and simple to construct; therefore, most people use a web page developer application such as Macromedia® Dreamweaver to create web pages. The following characteristics were considered when selecting to design a web page in Macromedia® Dreamweaver software for the WBT program task:

1) Unlikely that the participants had prior experience using the web development software
2) Learning how to use a "real world" tool
3) Face validity with an industrial task
4) Task complexity

The participants were trained to create a web page using Macromedia® Dreamweaver. Both training programs were completely web-based; therefore, no individual assistance was available to the participants during the training. There were two different websites (control and older-adult centered) to train the participants how to make a web page. Screen shots of the controlled and OAC training programs are in Appendix G. Half of the participants were exposed to the controlled WBT program and the other half of the participants were exposed to the OAC training program. For both training programs, there was no time limit to complete the WBT program and the participant could move through the training material at her/his own pace. The participant also had the freedom to return to previous training material or move forward to training material throughout the training session.

Both WBT programs were designed using the content provided in an introduction to Dreamweaver training provided by the Faculty Development Institute at Virginia Tech. The controlled WBT program was designed using web-based development guidelines about organization, structure, navigation, format, content, and appearance, suggested by Hartson and Hix (1999). In addition to using guidelines suggested by Hartson and Hix (1999), the OAC WBT program adapted the following characteristics suggested by Hollis-Sawyer and Sterns (1999) to improve the training for older adults: increase feelings of task motivation, interesting tasks, organized presentation of material, active participation in the learning process, and rapid feedback regarding progress. Hollis-Sawyer and Sterns (1999) concluded that implementing these characteristics in a training benefits most older adults, as well as younger adults, when learning new computer skills. In addition to these training recommendations, the OAC training incorporated design recommendations suggested by the National Institute on Aging and National Library of Medicine (2002): increase point size for text, use medium or bold face type, double space body of text, use short segments of animation or video, and use icons with text as hyperlinks.

Both WBT programs were designed to teach the participant how to complete a web page in Macromedia® Dreamweaver. To create a web page, the participant was required to learn the following tasks:

1) Open a blank page
2) Name web page
3) Save file
4) Change text alignment, font size, font style, and text color
5) Create a hyperlink (link), e-mail link, and image link
6) Insert an image into your web page
7) Preview web page.

To begin the WBT program, the participant clicked on the log-in icon located on the welcome screen of the WBT program. Once the participant logged-in, the training began. After going through the training material, the participant had the freedom to end the training when she/he were comfortable with the new information and believed she/he had been trained enough to create a web page without any additional training or assistance. To end the training, a log-out icon was available on every screen of the WBT program to allow the participant to end their training session at their convenience.

3.3.4. Computer application

After completing the training, the participant was required to create a web page using Macromedia® Dreamweaver without any assistance from the researcher. The participant was given a fictitious scenario (Appendix H) asking the participant to create a web page that included the following tasks:

1) Open a blank page
2) Name web page
3) Save file
4) Change text alignment, font size, font style, and text color
5) Create a hyperlink (link), e-mail link, and image link
6) Insert an image into your web page
7) Preview web page.

The tasks required for the web page were tasks taught in the WBT program. However, to reduce exact replication from the training, the fictitious scenario was used to slightly alter the information trained and the information required for the web page.

3.3.5. Observation and data recording

Camtasia Studio 2.0 was used to record the exploration, movement, and clicks the participant made while completing the WBT program. The software allowed the researcher to view and track the number of errors the participant made while completing the computer task. All of the other data was collected using on-line surveys. A knowledge assessment, subjective usability questionnaire, and the computer attitude scale were used to collect data.

3.3.6. Online questionnaires and assessments

The participant was required to complete the demographics questionnaire (Appendix C), the CSE questionnaire (Appendix A), and the knowledge assessment (Appendix D) on the computer. The participant was able to report her/his answers online by using *Survey.vt.edu*, an on-line tool developed for Virginia Tech students, faculty, and staff to create and run simple surveys, web site feedback and registration forms. For each on-line questionnaire and assessment, the researcher provided the participant a web site link to access and complete the questionnaires and assessment. There was no set time limit to finish the on-line documents.

3.4. Procedure

This experiment was conducted in the Macroergonomics and Group Decision Systems Laboratory. Because of limited funds to support this research, the participants were limited to only two hours to complete the study. The experiment included five major sections: (1) pre-screening (2) training session, (3) questionnaires, (4) computer application, and (5) questionnaire. Figure 2 shows a flowchart describing the procedures for this experiment.

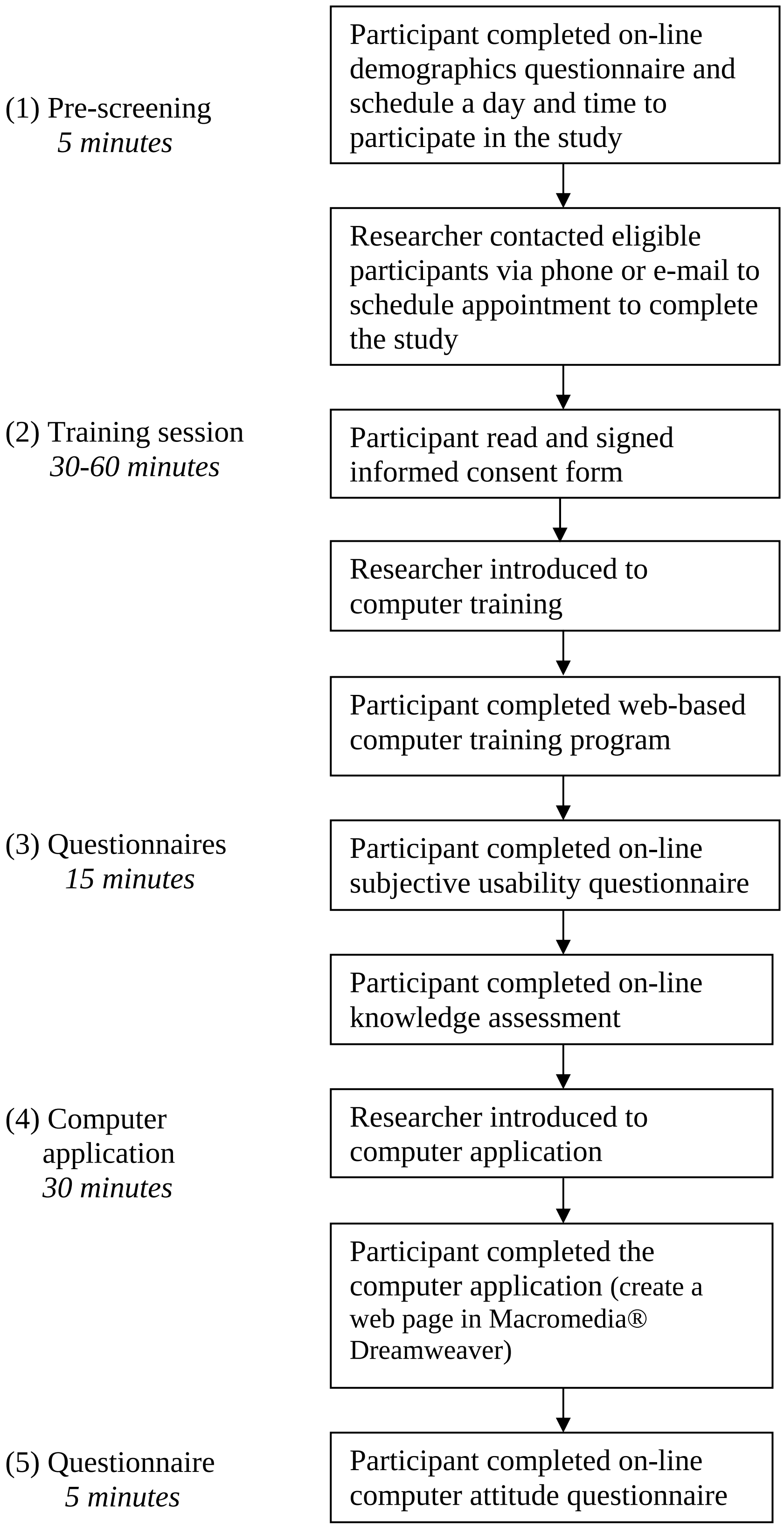

Figure 3. Flowchart describing the procedures for this experiment.

3.4.1. Pre-Screening

All interested participants were required to complete an on-line demographics questionnaire (Appendix C) which asked the participants information about their age, gender, computer experience, and work experience. The on-line demographics questionnaire also included questions about the participant's computer self-efficacy and knowledge about creating a web page in Macromedia ® Dreamweaver. After completing the demographics questionnaire, the researcher contacted all potential participants. If the participant was eligible for the study, the researcher scheduled an appointment for the participant to come to the laboratory to participate in the study. If the participant was not eligible for the study, the researcher thanked the participant for her/his interest in participating in the study and notified the individual they did not meet the requirements to participate in the study.

3.4.2. Training session and questions

In the laboratory, each participant was asked to read and sign the informed consent form (Appendix I) for the experiment. After signing the informed consent form, the researcher provided an overview of the training session. The researcher provided the participant an instruction manual and told the participant she/he could begin the WBT program. Then the researcher left the room to go into the observation room to monitor the participant. During the training session, the participant logged-in to the training and began the training. Once the participant finished the training, the participant logged-out of the training. Directly after completing the training, the participant completed the on-line subjective usability questionnaire (Appendix B) and the on-line knowledge assessment (Appendix D).

3.4.3. Computer application and questionnaire

Following the completion of the on-line subjective usability questionnaire and the on-line knowledge assessment, the participant was introduced to the computer application of the study. The researcher presented the participant a description of a fictitious scenario (Appendix H) the participant had to use to create a web page. To ensure the participant understood the instructions to complete the web page, the participant had to confirm they understood the task before starting the computer application. After the participant confirmed understanding of the computer application, the participant began creating a web page in Macromedia® Dreamweaver. Once the task was complete, the participant was required to print her/his web page. After printing her/his web page, the final part of the experiment required the participant to complete an on-line CSE questionnaire (Appendix A).

CHAPTER 4. RESULTS

4.1. Treatment of Data

As stated in Chapter 1, the goal of this study was to answer the following research questions:

1. How does the type of WBT (controlled or older-adult centered) impact task performance?
2. What are computer self-efficacy differences between younger and older adults?
3. How does computer self-efficacy impact task performance?
4. How does the usability (content, layout, animation, color, size) of the WBT program influence the older and younger adults' task performance?

To answer these questions, the statistical package, Statistical Analysis System (SAS), was used for the data analyses. The repeated measures two-way Analyses of Variance (ANOVA) and the univariate and three-way ANOVAs were conducted using the General Linear Model (GLM) procedure. All post hoc analyses used Least Squares Means (LSMeans). A correlation analysis was performed to identify significant associations between the independent and dependent variables (Table 4). For all analyses, the alpha was set at a level of 0.05. In addition, a content analysis was conducted to analyze the data from the open-ended questions on the subjective usability questionnaire.

Table 4. Dependent variables and description.

Dependent Variable	**Description**
Computer Self-efficacy – subjective response referring to the participant's computer attitude	Sum of the Likert scale responses to the 29 questions on the computer attitude questionnaire (low score = low computer self-efficacy and high score = high computer self-efficacy)
Training Time	The length of time it takes the participant to complete the WBT measured from when the participant clicks on the log-in icon to when the participant click on the log-off icon
Usability Rating - subjective response referring to the usability (layout, satisfaction, and information) of the training	Sum of the Likert scale responses to the 17 questions on the subjective usability questionnaire (low score = low usability rating and high score = high usability rating)
Knowledge Score	Determined by the number of questions answered correctly as defined by the knowledge assessment key (low score = low knowledge transfer = high knowledge transfer)
Task Completion Time	The length of time it takes the participant to complete the computer task measured from when the participant opens Macromedia ® Dreamweaver and to when the participant clicks on *print* to print the web page
Performance Score	Determined by evaluating the participant's performance via Camtasia and the number of subtasks successfully completed when creating the web page (low score = poor performance creating web page and high score = good performance creating a web page)
Performance Error	Determined by evaluating the participant's performance via Camtasia and the number of errors the participant made when creating the web page (e.g., clicking on wrong command)

Web Page Design Score	Sum of the Likert scale responses from an expert web page developer to 5 questions evaluating the participants final web page (low score = poor web page design and high score = good web page design)

A two-way ANOVA (age and gender) was conducted to compare the characteristics of the study's participants, 16 younger adults (M = 19 years old, SD = 1.39 years) and 16 older adults (M = 71 years old, SD = 5.12 years). Significant age-related differences were found for two questions from the demographics questionnaire (Appendix C) related to playing computer games and taking online classes. The younger adults (M = 1.56, SD = 0.51) played significantly more ($F_{3, 28} = 5.04$, $p < 0.05$) games than the older adults (M = 1.19, SD = 0.40). The younger participants (M = 1.75, SD = 0.44) also took significantly more ($F_{3, 28} = 5.04$, $p < 0.05$) online classes than their older counterparts (M = 1.38, SD = 0.50). The next four sections provide detailed results for each analysis conducted.

4.2. Repeated Measures Two-way ANOVA

The two dependent variables, knowledge and computer self-efficacy, were analyzed using a repeated-measures two-way ANOVA (age and training type). The two-way repeated-measures ANOVA was used to analyze the participants' pre-test scores and post-test scores for knowledge and computer self-efficacy. The pre-test and post-test questionnaires for knowledge (Appendix E) consisted of five questions from the total knowledge assessment questionnaire (Appendix D). The pre-test and post-test questionnaires for computer self-efficacy (Appendix E) consisted of six questions from the total computer self-efficacy questionnaire (Appendix A). A t-test was conducted on the participants' pre-test scores for knowledge and computer self-efficacy to confirm homogeneity of the two age groups. There were no significant differences for the pre-test scores for knowledge ($F_{1,30} = 0.66$, $p = 0.4461$) and computer self-efficacy ($F_{1,30} = 0.68$, $p = 0.4157$). Therefore, the age groups were homogenous. However, from pre-test to post-test, both knowledge assessment and computer self-efficacy changed significantly. The next two sections will discuss the direction of the changes of knowledge and computer self-efficacy from pre-test to post-test, and section 4.3 will provide the results for the total knowledge and total computer self-efficacy.

4.2.1. Knowledge

From pre-test to post-test, the repeated-measures ANOVA results revealed a significant gain in knowledge ($F_{7,24} = 161.83$, $p < 0.0001$) for both younger and older adults (Figure 4). Overall, the participants' knowledge post-test score ($M = 11.81$, $SD = 5.48$) was significantly higher than the participants' knowledge pre-test score ($M = 1.68$, $SD = 1.38$).

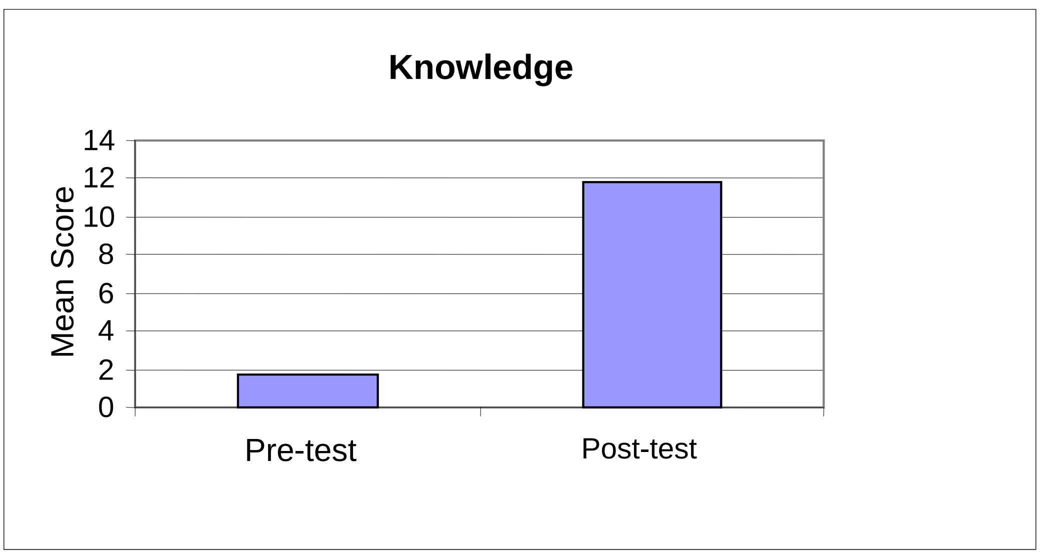

Figure 4. Knowledge pre-test and post-test scores (p < 0.0001).

Results of the repeated measures ANOVA revealed a significant interaction for the knowledge score difference from pre-test to post-test based on age. The younger adults gained significantly more knowledge ($F_{7, 24} = 161.83$, $p < 0.05$) from pre-test to post-test than the older adults (Figure 5). Post hoc results indicated that the younger adult participants scored significantly higher on their knowledge post-test score ($M = 14.00$, $SD = 5.53$) than the older adult participants ($M = 9.63$, $SD = 4.62$).

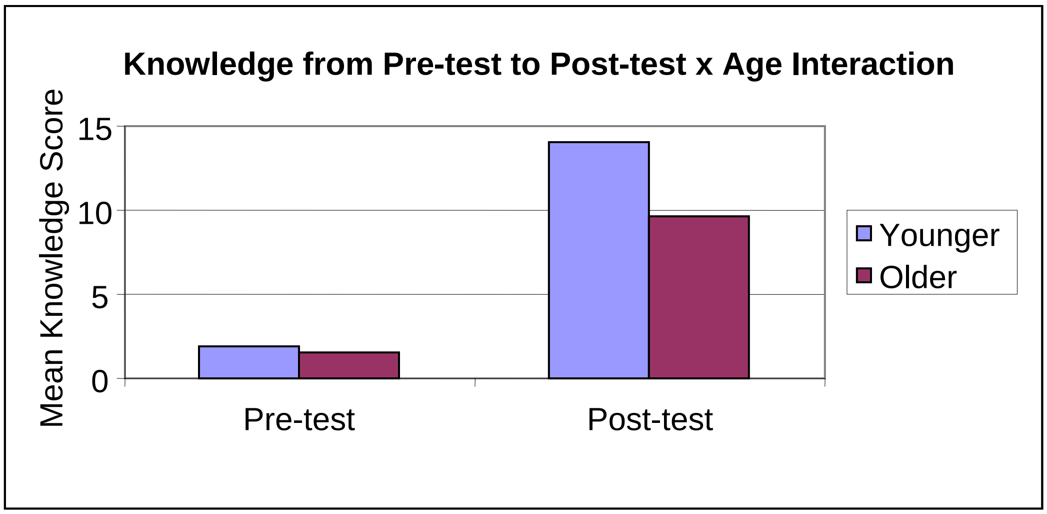

Figure 5. Pre-test to post-test by age interaction for knowledge pre-test and post-test scores (p < 0.05).

4.2.2 Computer self-efficacy

To check the reliability of the pre-test and post-test computer self-efficacy questionnaire for the participants in this study, Cronbach's alpha was calculated to determine the internal consistency of the items in the questionnaire. The reliability coefficient for the pre-test and post-test computer self-efficacy questionnaire was 0.75 and 0.80, respectively. These reliability coefficients indicate that both questionnaires were very reliable. The repeated-measures ANOVA results revealed that computer self-efficacy decreased significantly from pre-test to post-test ($F_{7, 24} = 75.81$, $p < 0.0001$) for both younger and older adults. The participants' computer self-efficacy pre-test score (*M* = 22.03, *SD* = 3.41) was significantly higher than the participants' computer self-efficacy post-test score (*M* = 18.09, *SD* = 2.62) (Figure 6).

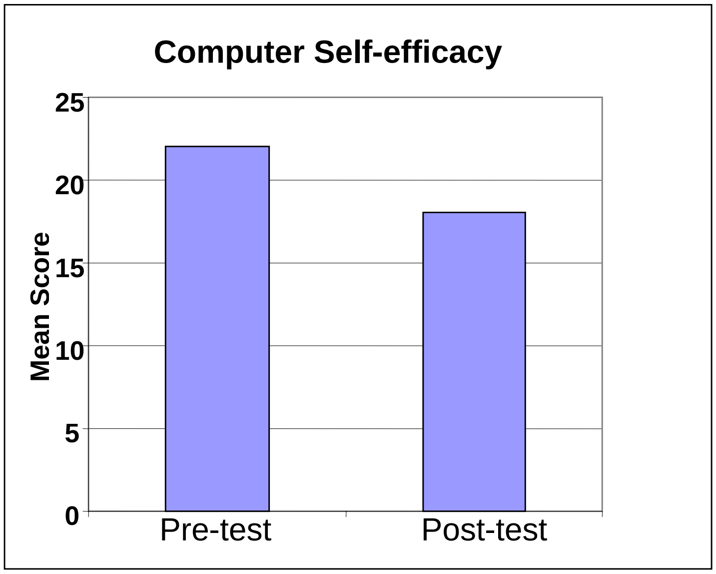

Figure 6. Computer self-efficacy score for pre-test and post-test (p < 0.0001).

There were significant differences in computer self-efficacy from pre-test to post-test based on training type. From pre-test to post-test, the computer self-efficacy decreased significantly more for the participants who received the older-adult centered (OAC) training ($F_{7, 24} = 5.50$, $p < 0.05$) than the controlled training. Post hoc results indicated that the younger and older adult participants who received the controlled training, computer self-efficacy post-test scores (*M* = 22.44, *SD* = 4.02) were higher than the younger and older adults who received the OAC training (*M* = 18.19, *SD* = 3.06) (Figure 7).

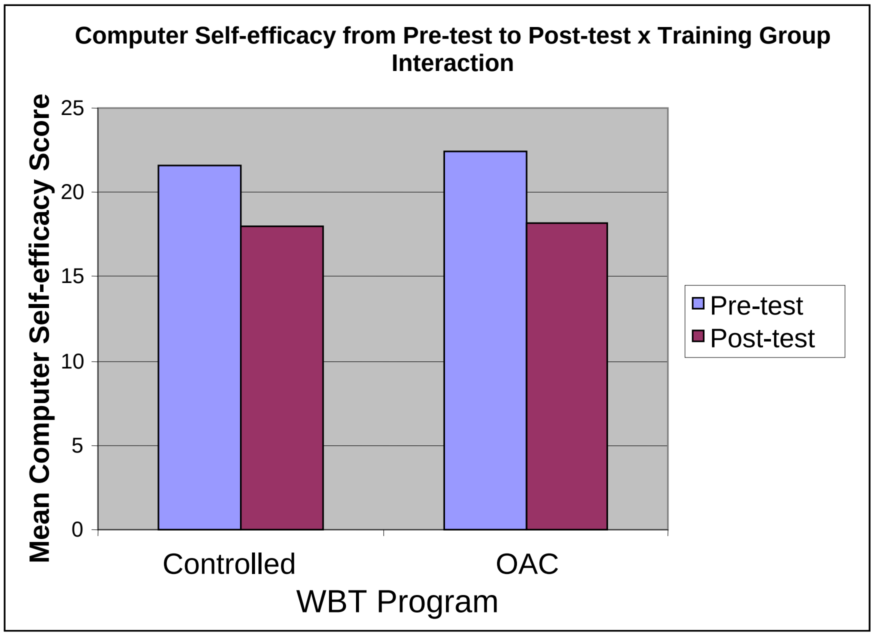

Figure 7. Computer self-efficacy scores from pre-test to post-test by training group interaction ($p < 0.05$).

4.3. Three-way ANOVA

To analyze the other dependent variables (total computer self-efficacy, training time, usability rating, total knowledge score, task completion time, performance score, performance error, and web page design score) in this study, three-way ANOVAs (age, gender, and training type) were conducted to determine the statistical significance for each dependent variable. Age was a significant main effect for training time, usability rating, task completion time, and performance score. No other significant main effects or interaction effects were found.

4.3.1. Training time

The results of the ANOVA for training time indicated a significant main effect by age ($F_{7, 24} = 25.22$, $p < 0.001$) (Table 5). The training time for the older adult participants (M = 49.19, SD = 11.95) was significantly higher than the younger adult participants (M = 28.94, SD = 9.30) (Figure 8).

Table 5. ANOVA summary table for training time.

Source	DF	SS	MS	F	p-value
*Age	1	3280.50	3280.50	25.22	0.001
Gender	1	66.13	66.13	0.51	0.483
Training Type	1	3.13	3.13	0.02	0.878
Age X Gender	1	24.50	24.50	0.19	0.668
Age X Training Type	1	12.50	12.50	0.10	0.759
Gender X Training Type	1	171.13	171.13	1.32	0.263
Age X Gender X Training Type	1	40.50	40.50	0.31	0.582
Error	24	3121.50	130.06		
Total	31	6719.88			

*Indicates significant difference

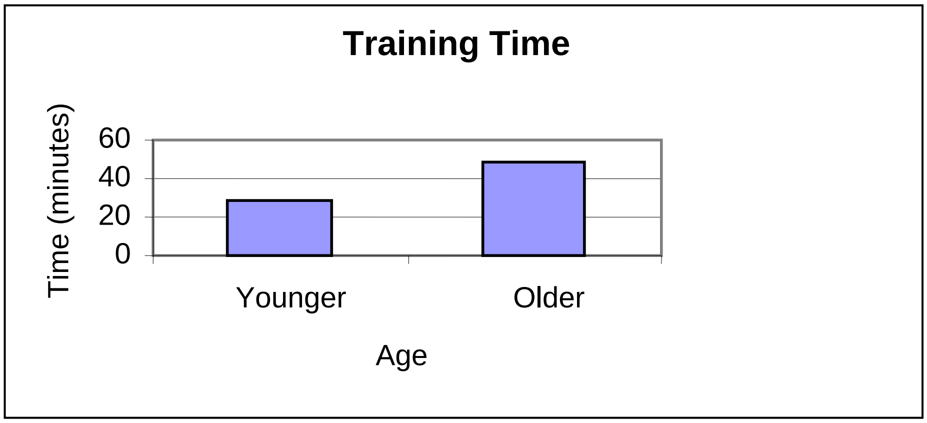

Figure 8. Training time by age (p < 0.001).

4.3.2. Usability

The results of the ANOVA indicated a significant main effect by age (Table 6).

Table 6. ANOVA summary table for usability ratings.

Source	DF	SS	MS	F	p-value
*Age	1	385.03	385.03	5.99	0.022
Gender	1	185.28	185.28	2.88	0.103
Training Type	1	108.78	108.78	1.69	0.206
Age X Gender	1	0.281	0.281	0.03	0.948
Age X Training Type	1	38.28	38.28	0.60	0.448
Gender X Training Type	1	81.28	81.28	1.26	0.272
Age X Gender X Training Type	1	101.53	101.53	1.58	0.221
Error	24	1542.75	64.28		
Total	31	2443.22			

*Indicates significant differences ($p < 0.01$)

To check the reliability of the subjective usability questionnaire for the participants in this study, Cronbach's alpha was calculated to determine the internal consistency of the items in the questionnaire. The reliability coefficient for this questionnaire was 0.65, which indicates that questionnaire items were reliable. Usability rating using the sum of the 30 satisfaction-related related questions differed significantly by age ($F_{7, 24} = 5.99$, $p < 0.01$). The older adult participants (*M* = 45.81, *SD* = 9.57) gave significantly higher usability ratings than the younger adult participants (*M* = 38.88, *SD* = 6.75) (Figure 9).

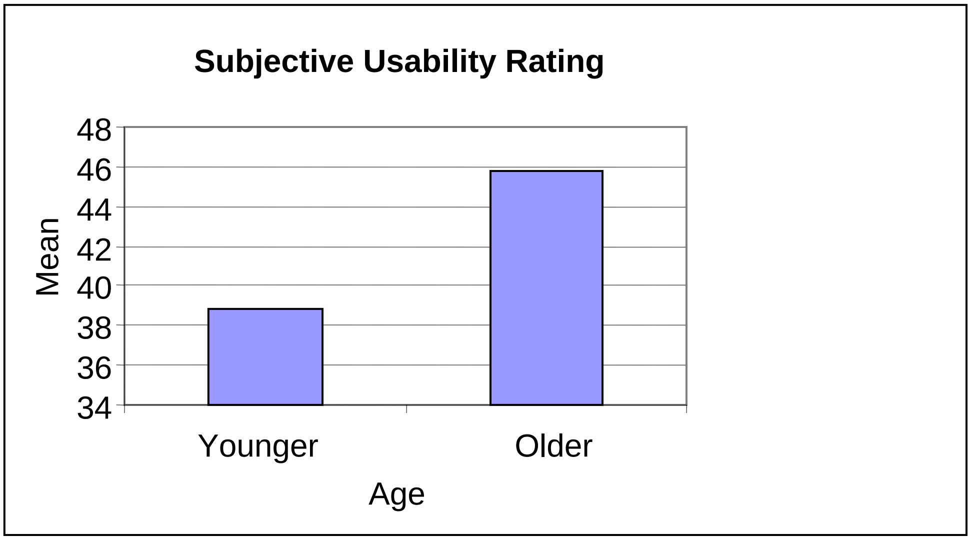

Figure 9. Subjective usability ratings by age (p < 0.01).

4.3.3. Task completion time

The results of the ANOVA FOR task completion time indicated a significant main effect by age ($F_{7, 24} = 10.35$, $p < 0.01$) (Table 7). The younger adult participants ($M = 23.94$, $SD = 5.98$) took significantly less time to design their web page than the older adult participants ($M = 34.13$, $SD = 12.09$) (Figure 10).

Table 7. ANOVA summary table for task completion time.

Source	DF	SS	MS	F	p-value
*Age	1	830.28	830.28	10.35	0.004
Gender	1	19.53	19.53	0.24	0.626
Training Type	1	94.53	94.53	1.18	0.289
Age X Gender	1	331.53	331.53	4.13	0.053
Age X Training Type	1	9.03	9.03	0.11	0.740
Gender X Training Type	1	318.78	318.78	3.97	0.058
Age X Gender X Training Type	1	30.03	30.03	0.37	0.546
Error	24	1925.25	80.22		
Total	31	3558.97			

*Indicates significant differences ($p < 0.01$)

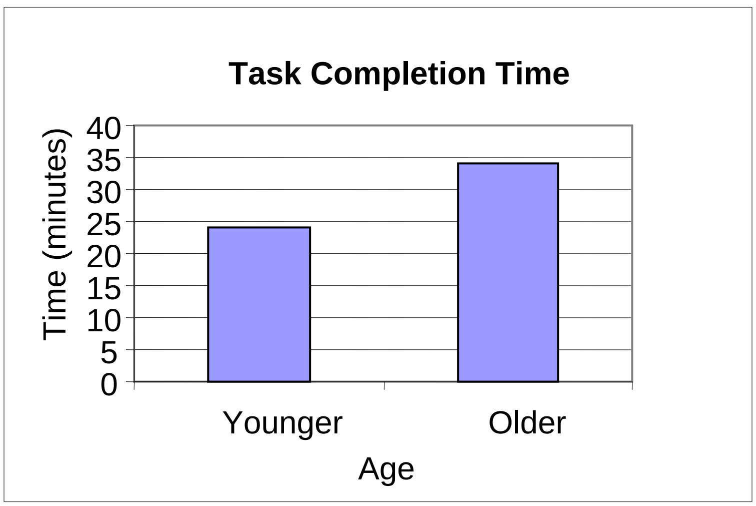

Figure 10. Task completion time by age ($p < 0.01$).

4.3.4. Performance

The results of the ANOVA for performance score indicated a significant main effect by age ($F_{7, 24} = 5.76$, $p < 0.05$) (Table 8). The younger adult participants ($M = 93.96$, $SD = 8.41$) performed significantly better than the older adult participants ($M = 81.07$, $SD = 19.89$) on the computer application portion of the study, creating a web page (Figure 11).

Table 8. ANOVA summary table for performance score.

Source	DF	SS	MS	F	p-value
*Age	1	1328.70	1328.70	5.76	0.025
Gender	1	16.25	16.25	0.07	0.793
Training Type	1	51.01	51.01	0.22	0.642
Age X Gender	1	42.78	42.78	0.19	0.671
Age X Training Type	1	270.28	270.28	1.17	0.290
Gender X Training Type	1	182.41	182.41	0.79	0.383
Age X Gender X Training Type	1	901.00	901.00	3.91	0.060
Error	24	5534.82	230.62		
Total	31	8327.24			

*Indicates significant differences (p < 0.05)

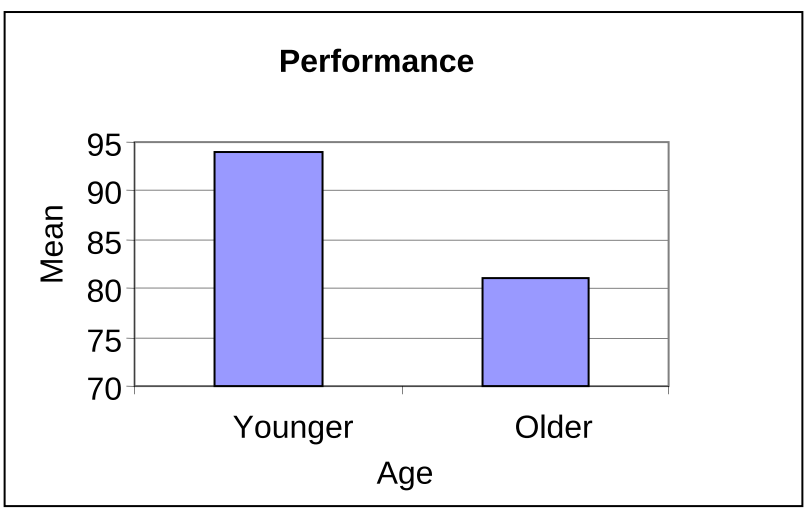

Figure 11. Performance score by age (p < 0.05).

4.3.5. Total computer self-efficacy

To check the reliability of the CSE scale for this study, Cronbach's alpha was calculated to determine the internal consistency of the items in the questionnaire. The reliability coefficient for this questionnaire was 0.86, which indicates that questionnaire items were extremely reliable. There were no significant differences between the total computer self-efficacy for younger adult participants (*M* = 54.38, *SD* = 15.31) and older adult participants (*M* = 60.25, *SD* = 11.17) (Figure 12).

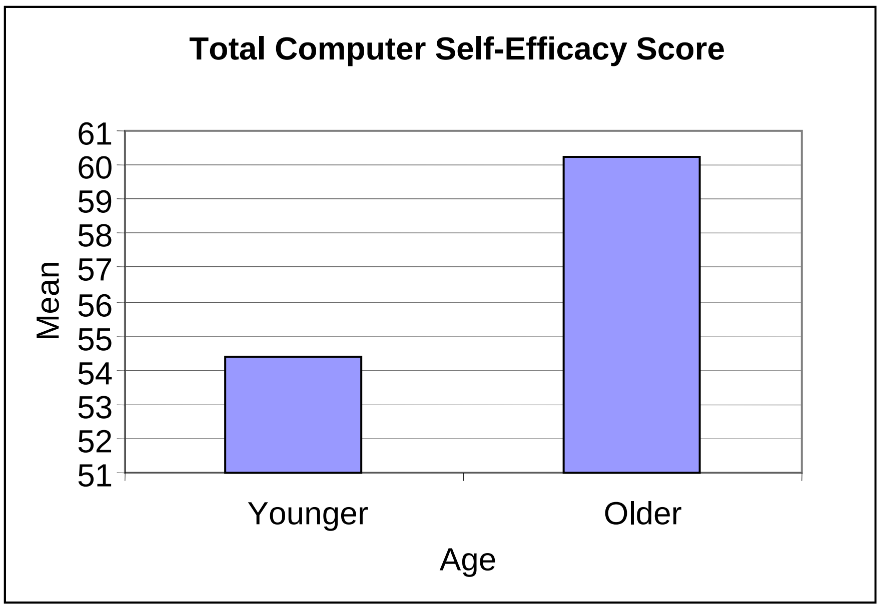

Figure 12. Total computer self-efficacy score by age.

4.3.6. Total knowledge score, performance error, and web page design

Total knowledge score, performance error, and web page design are three additional non-significant variables important in this study. There were no age-related differences for total knowledge score (*M* = 49.94, *SD* = 21.43), performance error (*M* = 1.53, *SD* = 1.65), and web page design (*M* = 12.47, *SD* = 2.48) (Figure 13).

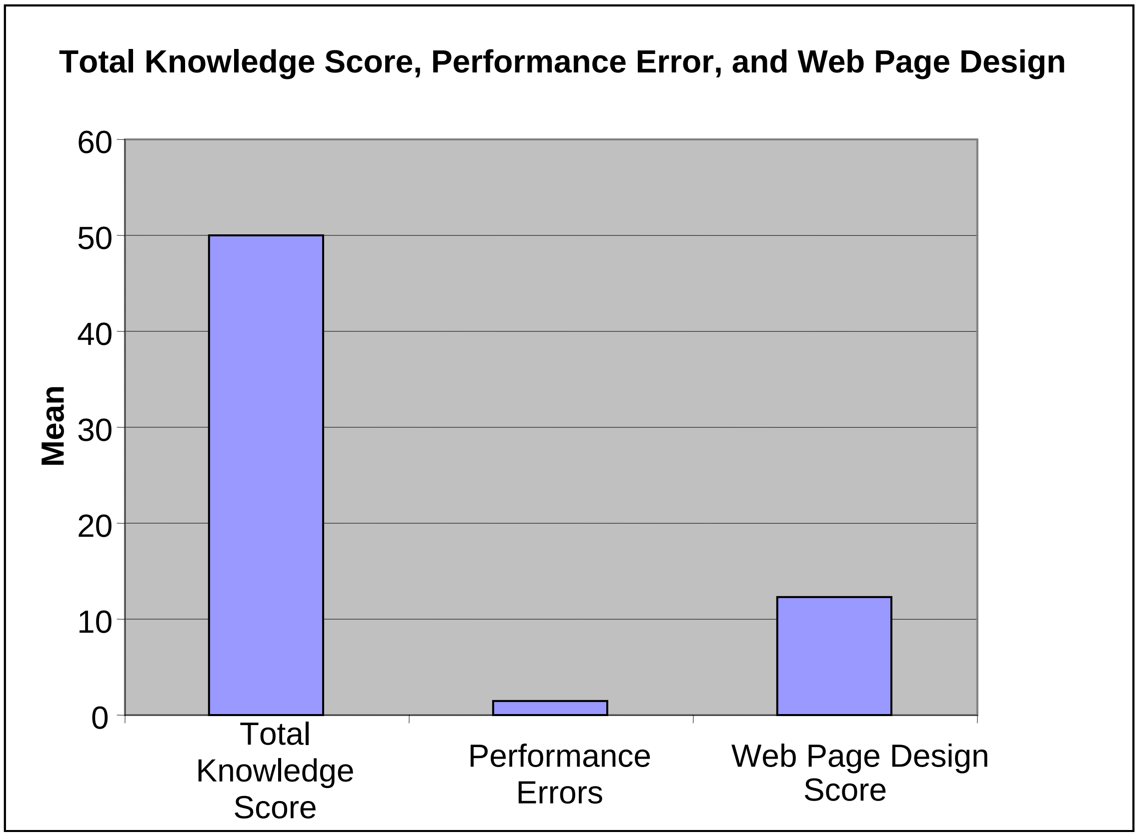

Figure 13. Results of total knowledge score, performance error, and web page design.

4.4. Correlation Analysis

A Pearson Correlation was conducted to further explain the relationships among the independent and dependent variables (age, training type, usability, total computer self-efficacy, total knowledge score, performance score, performance error, task completion time, and web score) (Table 9).

Table 9. Summary of correlation analysis.

Pearson Correlation Coefficients (r)

	Age	Training Time	Usability Rating	Total Computer Self-efficacy Score	Total Knowledge Score	Performance Score	Performance Error	Task Completion Time	Web Score
Age	------	0.70 *	0.40****	0.22	0.01	- 0.40 ****	0.06	0.48***	-0.14
Training Time		------	0.49***	0.37****	0.08	-0.23	0.3	0.37****	0.14
Usability Rating			------	0.55**	-0.14	-0.02	0.03	-0.04	-0.11
Total Computer Self-efficacy Score				------	0.06	-0.26	0.17	-0.08	-0.12
Total Knowledge Score					------	-0.01	0.27	0.10	0.21
Performance Score						------	-0.04	-0.28	0.18
Performance Error							------	0.26	-0.07
Task Completion Time								------	0.01
Web Score									------

**** = $p < 0.0001$, *** = $p < 0.001$, ** = $p < 0.01$, and * = $p < 0.05$

Age and training time

The results indicated a statically significant relationship between age and training time. This significant positive high relationship between age and training time indicates that an increase in the participant's age results in an increase in training time.

Age and usability rating

There was a significant positive relationship between age and usability rating. This relationship indicates that an increase in the participant's age results in a higher usability rating.

Age and performance score

The results indicated a statistically significant relationship between age and performance score. This significant negative relationship between age and performance score indicates that an increase in the participant's age results in a lower performance score.

Age and task completion time

Age and task completion time had a statistically significant relationship. This significant positive relationship between age and task completion time indicates that an increase in the participant's age results in an increase in task completion time.

Training time and usability rating

There was a significant positive relationship between training time and usability rating. This relationship indicates that an increase in training time results in an increase in usability rating.

Training time and total computer self-efficacy score

The results indicated a statistically significant relationship between training time and total computer self-efficacy score. This significant positive low relationship between training time and total computer self-efficacy score indicates that an increase in training time results in an increase in total computer self-efficacy score.

Training time and task completion time

The results indicated a statistically significant relationship between training time and task completion time. This significant positive low relationship between training time and task completion time indicates that an increase in training time results in an increase in task completion time.

Usability rating and total computer self-efficacy score

The results indicated a statically significant relationship between usability rating and total computer self-efficacy. This significant positive relationship between usability rating and total computer self-efficacy indicates that an increase in usability rating results in an increase in total computer self-efficacy score.

4.5. Content Analysis

A content analysis was performed on the open-ended responses from the subjective usability questionnaire (Appendix B). The results of the content analysis provided insight into design recommendations for future WBT programs.

First, all of the responses were divided by WBT programs. Coding was done separately for each type of WBT program (controlled and OAC). Each participant's response to the open-ended questions was coded into referential units. The referential units emerged from the open-ended responses. No preconceived notions about coding were developed. After coding all of the participants' responses, all of the coded responses for a single question were combined into one table. The frequency of occurrence of a coded response was also included in the table. Table 10 displays all of the referential units and frequency of occurrence for both the controlled and OAC WBT programs for the questions related to:

1. Text, font, and color preferences
2. Graphics (screenshots/videos)
3. Likes
4. Dislikes
5. Improving training

Table 10. Codes and frequency for content analysis.

Controlled WBT Program			OAC WBT Program	
Code (Referential unit)	**Frequency**		**Code (Referential unit)**	**Frequency**
1. Would you have preferred another text size, font size, or color for the text?				
Current settings adequate	6		Current settings adequate	8
Different font	3		Larger text	4
Larger text	2		Different font	4
			Smaller text	1
2. How useful did you find the screenshots (controlled)/ videos (OAC) that were included in the training?				
Helpful	12		Helpful	10
Essential	2		Not helpful	1
Not helpful	2			
3. What did you like about the training?				
Easy to understand	7		Easy to understand	7
Self-paced	4		Instructions	4
Images	4		Quizzes	3
Layout	3		Self-paced	2
Quizzes	3			
4. What did you dislike about the training?				
Nothing	3		Nothing	2
Redundant information	2		Size of video	2
Too much information	2		Speed of video	2
Interaction	1		Format of lessons	1
Format of lessons	1			
5. What would you add to the training to help you learn better?				
Interaction	5		Interaction	3
More instructions	4		Slow down videos	2
Nothing	3		More instructions	1
Lesson overview	1		Nothing	1

CHAPTER 5. DISCUSSION

5.1. Knowledge and Computer Self-efficacy

The primary objectives of this study were to design a WBT program to accommodate age related degradations related to cognitive aging and examine if an individual's computer self-efficacy is affected by learning new computer software through WBT. Both the younger and older adult participants equally learned a new skill from the WBT program. This research supports the literature (Mead and Fisk, 1997; Morrell, Park, Mayhorn, and Kelley, 2000; Sharit and Czaja, 1994; Zandri and Charness, 1989), which suggests that older adults can learn a new computer skill just as their younger counterparts.

The individuals' computer self-efficacy score decreased significantly from pre-test (before the training) to post-test (after the training and application). Prior to the training, the mean computer self-efficacy score for both younger and older adults was higher than the mean computer self-efficacy score for both younger and older adults at the end of the training. These results could have occurred because of the measurement tool used. Cassidy and Eachus' computer self-efficacy scale (2002) is designed to rate an individuals' overall computer self-efficacy. Self-efficacy is considered domain specific because self- efficacy levels are thought to be determined by previous experience (success and failures), choice of task, motivational level and effort, and perseverance of the task (Cassidy and Eachus, 2002). It is possible that at the end of the study, the participants rated their capabilities to successfully complete the training, training assessments, and/or creating a web page rather than their overall experience with computers. Therefore, the measurement was sensitive to the task. As novice web page designers, the participants may not have been confident creating their own web page immediately after the training session. This could have resulted in lower computer self-efficacy scores for both the younger and older adults.

5.2. Training Type

Research question one explored the effect of the type of WBT program (controlled or OAC) on task performance. It was hypothesized that the OAC training program would yield better performance for both younger and older adults than the controlled training. Although the younger and older adults learned from both WBT programs, this study could not confirm significant differences between the controlled WBT program and the OAC WBT program. Based on the three-way ANOVA, the main effect, training type, was not significant. Likely explanations are that both the controlled WBT program and the OAC WBT program were good designs, and the two designs were not different enough to provide significant performance results. Both WBT programs were designed based on guidelines for an effective WBT program, but the OAC WBT program had a few modifications which were suggested by Hollis-Sterns and Sawyer (1999) to help older adults learn better. The differences between the two training programs were text size, spacing, and the use of video animation. The OAC WBT program had larger text; text was double-spaced; and the instructions to complete the tasks were supplemented by videos demonstrating how to complete the task.

5.3. Computer Self-efficacy

For research question two, it was hypothesized that older adults would have a lower computer self-efficacy score than younger adults. This hypothesis was not supported (Appendix J). The lack of significant difference for computer self-efficacy between older and younger adults may be because all of the participants were experienced computer and Internet users.

Every participant had at least four years of computer and Internet experience which could explain high computer self-efficacy scores prior to the study and perhaps confidence in learning a new computer skill. The participants were required to be experienced computer and Internet users to ensure the application task was not to simple, but complex enough to be sensitive to age.

The hypothesis for research question three was participants with higher computer self-efficacy would perform better creating a web page than participants with lower computer self-efficacy. Computer self-efficacy did not significantly differ for any of the performance measurements (task completion time, performance score, web page score, and performance error). Most of the participants had high computer self-efficacy scores prior to participating in the training, thus, a ceiling effect may have occurred (i.e., when most of the responses are on the highest end of the rating scale, Martin, 2000). The highest pre-test score for computer self-efficacy was 25 on a scale from 0-25, and the mean for the participants' pre-test computer self-efficacy scores was 22.69 (*SD = 3.41)*. With high initial self-computer efficacy scores, the ceiling effect implies that the mean computer self-efficacy would remain the same or decrease. In this study, participant's scores decreased from pre-test to post-test. A possible explanation for the decrease in computer self-efficacy from pre-test to post-test was explained in section 5.1.

5.4. Usability

The fourth research question asked how does usability (content, layout, animation, color, size) of the WBT impact the trainee's task performance. It was hypothesized that the participants with the higher usability ratings would finish the task in the least amount of time and perform the fewest number of errors. The main effect, usability, was not significant for the performance measurements (task completion time, performance score, web page score, and performance error). Most of the participants had high usability ratings for the WBT programs.

These high usability ratings could be a result of having a good design for both the WBT and the controlled training programs. The limited variability between the controlled WBT program and the OAC WBT program may have also contributed to the lack of significant findings. Although usability was not significant for the performance measurements, usability was significant by age.

Based on the three-way ANOVA (Table 6), usability ratings were significantly higher for the older adult participants. Significantly higher usability ratings for older adults indicate that the older adults found the WBT programs more useful, easier to learn from, and easier to use than the younger adults. During the study, the older adults often mentioned using a web page to post pictures and information for their family and friends. The older adults perhaps had higher usability ratings because they were more eager than the younger adults to learn to create their own web page.

5.5. Training Time, Task Completion Time, and Performance

The main effect, age, was a significant factor in this study. Differences occurred for training time, task completion time, and performance score (Tables 5, 7, and 8). It took the older adult participants significantly longer to complete the WBT program and the computer application than their younger adult counterparts. The older adults also scored significantly lower on the performance score. Previous studies (Charness, Schumann, Boritz, 1992; Mead and Fisk, 1997; and Zandri and Charness, 1989) also concluded that older adults take longer to learn a new computer skill and score lower than younger adults on skills test. Older adults may take more time to complete the training and computer application because many older adults have slower response times, have difficulty performing new tasks, and the lack of repetition and practice of the new skill (Spry Foundation, 1999). In addition, as individuals age, their working memory declines (Salthouse, 1996). The older adult participants' decline in working memory may have caused training information to be lost when being processed, thus not allowing them to remember and recall as much training information as their younger counterparts.

5.6. Knowledge, Performance Error, and Web Page Design

Some of the non-significant differences in this study suggest important outcomes for WBT programs for younger and older adults. There were no age-related differences for the performance measurements (knowledge score, performance error, and web page design score). Both younger and older adults equally learned how to create a web page and made the same number of errors when creating their web page. There were no age-related differences in the design of the web pages; both the younger and older adults created web pages with text, graphics, and functioning links. An explanation for these results could be because the WBT program was self-paced and included interactive quizzes. Based on the findings of the content analysis, both the younger and older adults liked the opportunity to control the pace of going through the WBT program and the interactive quizzes. Because the WBT programs were self-paced, the participants had the opportunity to control the amount of time they spent on the different lessons and quizzes. Short quizzes were completed at the end of each lesson. The quizzes assessed the participants' knowledge learned in each lesson. After completing the quiz, the participants received their score for the quiz, were able to review the correct answers for each quiz question, and told to review the lesson again if they answered more than one quiz question incorrectly. The quizzes could have helped the participant retain and remember the information learned in the training. Past studies (Mead and Fisk, 1997; Morrell, Park, Mayhorn, and Kelley, 2000; Sharit and Czaja, 1994; Zandri and Charness, 1989) revealed that older adults typically make more errors than their younger counterparts, but this study indicated that neither age group made significantly more or significantly less errors than the other age group. When learning a new computer task, these non-significant differences conclude that equality between younger and older adults can possibly be achieved. Web-based training programs can perhaps be designed to accommodate age related differences related to knowledge, design, and performance error.

CHAPTER 6. CONCLUSION

6.1. Design Recommendations

Based on the analysis of the responses to the open ended questions from the usability survey, this study confirmed the following recommendations suggested by Hollis-Sawyer and Sterns (1999):

1) Provides structure in learning the task
2) Organizes the presentation of material
3) Permits active participation in the learning process
4) Provides rapid feedback regarding progress
5) Is sensitive to the pacing preferences of older trainees

Table 11 explains how each recommendation was designed into the WBT programs.

Table 11. Research characteristics and conditions.

Characteristics suggested by literature	**Controlled training**	**Older-adult centered training**	**Recommendations derived from statistical analysis or content analysis**
Provides structure in learning the task	Training adapted from Faculty Development Institute	Training adapted from Faculty Development Institute	Content analysis and Statistical analysis *(Repeated-measures ANOVA for knowledge)*
Organizes the presentation of material	10-14 point text size	14-20 point text size	Content analysis
Permits active participation in the learning process	None	Videos demonstrate how to complete tasks	Content analysis
Provides rapid feedback regarding progress	Quizzes at end of training provides immediate feedback	Quizzes at end of training provides immediate feedback	Content analysis
Is sensitive to the pacing preferences of older trainees	WBT is self-paced	WBT is self-paced	Content analysis

These characteristics suggested by Hollis-Sawyer and Sterns (1999) are recommended when designing an OAC training. Because the usability ratings were significantly higher for the older adult participants, and there were no significant differences between knowledge score, web page design score, and performance error, additional design recommendations were created based on the results of the content analysis. Participant examples are provided to exemplify the recommendations.

1) Provide an interactive review assessment to allow trainee to demonstrate knowledge gained in training. *(Recommendation derived from content analysis.)*

   Participant 4 stated: *Quizzes at end did a good job of helping me understand the information.*

   Participant 5 stated: *Liked quizzes, they confirmed that I understood the lessons.*

   Participant 11 stated: *Quizzes reinforced my learning.*

2) Provide an opportunity for the trainee to practice the skilled being trained within the training tutorial. *(Recommendation derived from content analysis.)*

   Participant 2 stated: *Provide opportunity to prepare a web page in the training.*

   Participant 4 stated: *Instead of video, have a part where you actually have to do the steps being taught.*

   Participant 13 stated: *Training should ask me to make my own website using the demonstrated information.*

3) Provide users the ability to control the speed of animation. *(Recommendation derived from content analysis.)*

Participant 8 stated: *Speed of videos was just right.*

Participant 12 stated: *Videos were too fast.*

Participant 17 stated: *Having the ability to control the speed of the tutorial actions will help me learn better.*

6.2. Limitations and Assumptions of Study

A principal limitation in the study arose from the computer-self efficacy (CSE) scale used. Cassidy and Eachus' CSE scale (2002) was designed to rate an individuals' overall computer self-efficacy. For this study, it is possible the participants rated their capabilities to successfully complete the training, training assessments, and creating a web page rather than their overall experience with computers.

Another limitation in the study was the environment. It was designed to simulate the WBT program in the workplace. The participants had the opportunity to take notes throughout the training. However, the notes were not used to complete the knowledge assessment and computer application portion of the study. Although the experimental environment was designed to simulate WBT, time pressures were applicable to the study. Because of limited funds to support this research, participants could only spend up to two hours to complete the training program. Some of the older adults took more than one-hour to complete the training program. Although none of the participants took up to two-hours to complete the training, they were aware of the time constraint, which could have put time pressure on the participants in the study.

6.3. Future Research and Lessons Learned

Because computer self-efficacy (CSE) was a major factor in this study, it would be ideal to replicate this study using a different CSE scale. Cassidy and Eachus' (2002) CSE scale could be modified to make the CSE questions more specific to designing a web page, rather than general questions related to computer use.

The results from this study indicated that the interaction between age and gender approached significance ($F_{7, 24} = 10.35$, $p = 0.053$). A larger sample of participants could have resulted in a significant interaction between age and gender. Future studies should further explore gender differences in training individuals a new computer skill.

Future studies can build upon this study by investigating age related differences among the older population. Morrell et al. (2000) found age-related differences among the older population when training older adults how to use an electronic bulletin board system. There were similar differences among the older population in this study, therefore, future studies can be designed to look at the young-old (65-74 years old), old-old (75-79 years old), and the oldest-old (80 years old and over) age groups. Future studies can incorporate participatory design methods when designing training programs for older adults. Perhaps, older adults can provide insight on important concepts or techniques that may be overlooked during the developmental phase of the WBT program.

Finally, the major lesson learned in this study was the challenge of creating an OAC design. An OAC design should be a universal design to accommodate both younger and older adults. Although the size of the text was enlarged in the OAC training, the size of the video should have been enlarged also. In addition, the speed of the video was too fast for most of the participants. Using the lessons learned in this study to improve the design of training for both younger and older adults, the researcher should combine characteristics of the controlled and OAC conditions. Animation and videos can compliment pictures demonstrating different tasks being taught. Larger text was preferred by both younger and older adults so larger text and larger pictures and videos should be used in the training. In addition, the speed of the video should be controllable by the participants. To help the participants learn and remember the tasks, exercises requiring the participant to demonstrate the tasks learned during the training should be designed into the training. Future research can be performed to compare current training programs with a training program that is altered based on the lessons learned and the recommendations given in this thesis.

6.4. Overall Conclusion

There are two primary things of interest to be noted with reference to the results of this study. First, it should be reiterated that although there were no significant findings in training type, all of the individuals learned how to create a web page from the WBT. In support of the literature (Mead and Fisk, 1997; Morrell, Park, Mayhorn, and Kelley, 2000; Sharit and Czaja, 1994; Zandri and Charness, 1989), this study concluded that older adults can learn new computer skills through WBT. During the study, the researcher also observed a generational effect, most of the older adult participants were very eager to learn a new computer skill. Several older adults made comments about creating web pages to post pictures of their grandchildren. The younger adult participants did not appear to see the value in just learning how to create a web page. The open-ended questions on the subjective usability questionnaire revealed that creating a web page was not challenging enough for the younger generation who grew up using computers on a regular basis. Past aging research has found that older trainees benefit less from training than younger adult (Kubeck, Delp, Haslett, and McDaniel, 1996). In this study, the opposite was found. Based on the open-ended questions in the subjective usability questionnaire, most of the older adults enjoyed the WBT program the most and stated they planned to explore web page design in the future.

The findings of this and previous studies (Charness and Bosman, 1990; Charness, Kelly, Bosman, and Mottram, 2001; Czaja, 1996; Fisher, 2001) provide is evidence that older adults can learn new computer tasks as well as their younger counterparts. The result of no difference between age and knowledge, web page design, and performance error indicates that training programs can be designed to provide the opportunity for both younger and older adults to learn equally. To further explore other ways to increase equality between younger and older adults, future research should compare the training effectiveness of two WBT programs that differ significantly (e.g. text size, color, automation speed, training approach). Although this research might be more difficult and time consuming to conduct, it is believed that results of a study that examine this idea would be a great contribution to existing literature, as age related differences continue to exist between younger and older adults for learning new computer skills. When designing WBT programs, the audience should be considered to have an effective design. Both younger adults and older adults would benefit from improvements to WBT programs.

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APPENDIX A: Computer Self-efficacy Scale

COMPUTER ATTITUDE QUESTIONNAIRE

Instructions: The purpose of this questionnaire is for you to provide some information about your experience using computers. Please respond to the following statements by checking the block that most accurately depicts your opinion concerning how you feel about computers. There are no 'correct' responses; it is your own views that are important.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1. Most difficulties I encounter when using computers, I can usually deal with.					
2. I find working with computers very easy.					
3. I am very unsure of my abilities to use computers.					
4. I seem to have difficulties with most of the packages I have tried to use.					
5. Computers frighten me.					
6. I enjoy working with computers.					
7. I find computers get in the way of learning.					
8. When using computers I worry that I might press the wrong button and damage it.					
9. Computers make me much more productive.					
10. I often have difficulties when trying to learn how to use a new computer package.					

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
11. Most of the computer packages I have had experience with, have been easy to use.					
12. I am very confident in my abilities to use computers.					
13. I find it difficult to get computers to do what I want them to.					
14. At times I find working with computers very confusing.					
15. I would rather that we did not have to learn how to use computers.					
16. I usually find it easy to learn how to use a new software package.					
17. I seem to waste a lot of time struggling with computers.					
18. Using computers makes learning more interesting.					
19. I always seem to have problems when trying to use computers.					
20. Some computer packages definitely make learning easier.					
21. Computer jargon baffles me.					
22. Computers are far too complicated for me.					
23. Using computers is something I rarely enjoy.					
24. Computers are good aids to learning.					

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
25. Sometimes, when using a computer, things seem to happen and I don't know why.					
26. As far as computers go, I don't consider myself to be very competent.					
27. Computers help me to save a lot of time.					
28. I find working with computers very frustrating.					
29. I consider myself a skilled computer user.					
30. The training made it easy for me to create my own web page.					
31. I would use this type of training again to learn another new computer skill.					

APPENDIX B_1: Subjective Usability Questionnaire (Screenshots)

SUBJECTIVE QUESTIONNAIRE

<u>Instructions</u>: Please respond to the following statements by checking the block that most accurately depicts your opinion concerning the training you completed. There are no 'correct' responses; it is your own views that are important.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1. Overall, I found the layout of the training appealing.					
2. I liked the colors used in the training.					
3. I was able to answer the quiz questions easily.					
4. I had difficulty answering the quiz questions.					
5. Overall, the layout of the training was frustrating.					
6. The text was clear to read.					
7. I liked the feedback (correct and incorrect answers) given in the quiz section of the training.					
8. The feedback (correct and incorrect answers) given in the quiz section of the training was easy to understand.					
9. I am confident that I can use this training easily.					
10. I will feel uncomfortable trying to use this training again.					
11. The picture in the top-left corner of the training was a distraction.					
12. The tasks were easy to learn.					
13. I felt motivated to complete the training.					
14. I enjoyed going through the pictures demonstrating the different steps to create a web page.					
15. The instructions describing the different steps to create a web page were easy to understand.					

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
16. I found the organization of the information easy to understand.					
17. I felt motivated to participate in the training.					
18. Overall, I found the training experience rewarding.					
19. I learned very little about creating a web page through the training.					
20. I am satisfied with my training experience.					
21. I was comfortable with the way I was taught to create a web page.					
22. I feel the training gave me too much information.					
23. Overall, the training was frustrating.					
24. I enjoyed learning to use Dreamweaver software to create a web page.					
25. I liked the way Dreamweaver was explained to me.					
26. I think the training approach used was a very efficient way to teach the material.					
27. I do not feel that I understand how to make a web page using Dreamweaver software.					
28. The instructions were easy to understand.					
29. It was hard to follow the training.					
30. I found the training approach used to be very effective.					

Please write responses to the following questions.

1. Did you like the training? Why or why not?

2. What, if any, changes would you make to make the training better?

3. What did you like best about the training?

4. Would you have preferred another text size, font size or color for text?

5. What did you not like about the training?

6. What would you add to the training to help you learn better?

7. Would you have preferred more or less information per page? Why?

8. How useful did you find the pictures that were included in the training?

9. Would you have preferred more or less pictures explaining how to create a web page in the training? Why?

10. Please type any additional comments or suggestions you may have regarding the training.

APPENDIX B_2: Subjective Usability Questionnaire (Video)

SUBJECTIVE QUESTIONNAIRE

Instructions: Please respond to the following statements by checking the block that most accurately depicts your opinion concerning the training you completed. There are no 'correct' responses; it is your own views that are important.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1. Overall, I found the layout of the training appealing.					
2. I liked the colors used in the training.					
3. I was able to answer the quiz questions easily.					
4. I had difficulty answering the quiz questions.					
5. Overall, the layout of the training was frustrating.					
6. The text was clear to read.					
7. I liked the feedback (correct and incorrect answers) given in the quiz section of the training.					
8. The feedback (correct and incorrect answers) given in the quiz section of the training was easy to understand.					
9. I am confident that I can use this training easily.					
10. I will feel uncomfortable trying to use this training again.					
11. The picture in the top-left corner of the training was a distraction.					
12. The tasks were easy to learn.					
13. I felt motivated to complete the training.					
14. I enjoyed going through the videos demonstrating the different steps to create a web page.					
15. The instructions describing the different steps to create a web page were easy to understand.					

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
16. I found the organization of the information easy to understand.					
17. I felt motivated to participate in the training.					
18. Overall, I found the training experience rewarding.					
19. I learned very little about creating a web page through the training.					
20. I am satisfied with my training experience.					
21. I was comfortable with the way I was taught to create a web page.					
22. I feel the training gave me too much information.					
23. Overall, the training was frustrating.					
24. I enjoyed learning to use Dreamweaver software to create a web page.					
25. I liked the way Dreamweaver was explained to me.					
26. I think the training approach used was a very efficient way to teach the material.					
27. I do not feel that I understand how to make a web page using Dreamweaver software.					
28. The instructions were easy to understand.					
29. It was hard to follow the training.					
30. I found the training approach used to be very effective.					
31. I enjoyed having the animated videos in the training.					
32. The animated videos in the training were to fast for me to fully understand the information in the training.					

Please write responses to the following questions.

1. Did you like the training? Why or why not?

2. What, if any, changes would you make to make the training better?

3. What did you like best about the training?

4. Would you have preferred another text size, font size or color for text?

5. What did you not like about the training?

6. What would you add to the training to help you learn better?

7. Would you have preferred more or less information per page? Why?

8. How useful did you find the videos that were included in the training?

9. Would you have preferred more or less videos explaining how to create a web page in the training? Why?

10. Would you have preferred more or less pictures in the training? Why?

11. Please type any additional comments or suggestions you may have regarding the training.

APPENDIX C: Demographics Questionnaire

DEMOGRAPHICS QUESTIONNAIRE

The purpose of this questionnaire is for you to provide some basic background information about yourself and your experience of computers, if any. Please complete the following demographics questionnaire.

BACKGROUND INFORMATION

Gender: _____ Female _____ Male

Ethnicity: _____ African-American (Black)
_____ Asian-American (Chinese-American, Korean-American, Indian-American)
_____ European-American (White, Caucasian)
_____ Hispanic-American (Latino, Latin-American)
_____ Native-American (American Indian)
_____ Other (If so, what ethnicity?: ______________________________)

Age: __________

How many YEARS of work experience do you have? _____ 0-1
_____ 2
_____ 3
_____ 4

What job positions have you held?

COMPUTER EXPERIENCE

Please respond to the following statements by checking the block that most accurately depicts your response to the question.

	0-1	2	3	4 or more
How many **YEARS** have you used a computer?				
How many **YEARS** of experience have you had using the Internet (World Wide Web)?				
On average, how many **HOURS** do you spend on a computer when you use it?				
On average, how many **HOURS** do you spend on e-mail and/or online chat each time you do so?				

	0-1	2-3	4-5	6 or more
On average, how many **TIMES** do you use a computer per week?				
On average, how many **TIMES** do you use e-mail and/or online chat per week?				
On average, how many **TIMES** do you use an internet browser, such as, Internet Explorer, AOL, or Netscape per week? (Do not include time spent e-mailing or chatting.)				
On average, how many **HOURS** do you spend using an internet browser each time you use it? (Do not include time spent e-mailing or chatting.)				

Please respond to the following statements by checking the block that most accurately depicts your response to the question.

	Yes	No
Do you play computer games?		
Have you ever taken computer classes?		
Have you ever taken a class that was taught on computers?		

Do you have any computer experience with the following: *(if you are unsure, select "No")*

	Yes	No
Word processing such as Microsoft Word		
Using spreadsheets such as Microsoft Excel		
Using drawing software such as Corel Draw or Microsoft Paint		
Using database management systems such as Microsoft Access		
Using programming language such as Java, HTML, Authorware, Director, or Visual Basic		
Building web pages using FrontPage or Dreamweaver		

APPENDIX D: Knowledge Assessment

KNOWLEDGE ASSESSMENT

Instructions: The purpose of this assessment is to examine your understanding of the concepts learned in the training. Please answer the following questions to the best of your ability.

1. How do you create an email link on a web page?

2. How do you insert a picture on a web page?

3. How do you make a picture a link on a web page?

4. How do you make text a link on a web page?

5. How do you save a web page?

6. What changes can be made to the text on a web page?

7. How do you change the alignment or position of the text or pictures on a web page?

8. How do you change the color of the text on a web page?

APPENDIX E: Pre and Post Questions

Knowledge Assessment

Instructions: The purpose of this assessment is to examine your understanding of the concepts that will be taught in the training. Please answer the following questions to the best of your ability.

1. How do you create an email link on a web page?
2. How do you insert a picture on a web page?
3. How do you make a picture a link on a web page?
4. How do you change the alignment or position of the text or pictures on a web page?
5. How do you save a web page?

Computer Attitude

Instructions: The purpose of this questionnaire is for you to provide some information about your experience using computers. Please respond to the following statements by checking the block that most accurately depicts your opinion concerning how you feel about computers. There are no 'correct' responses; it is your own views that are important.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1. Most difficulties I encounter when using computers, I can usually deal with.					
2. I find working with computers very easy.					
3. I enjoy working with computers.					
4. I find computers get in the way of learning.					
5. I am very confident in my abilities to use computers.					
6. I usually find it easy to learn how to use a new software package.					

APPENDIX F: Web Page Design Ratings Sheet

Web Page Design Ratings

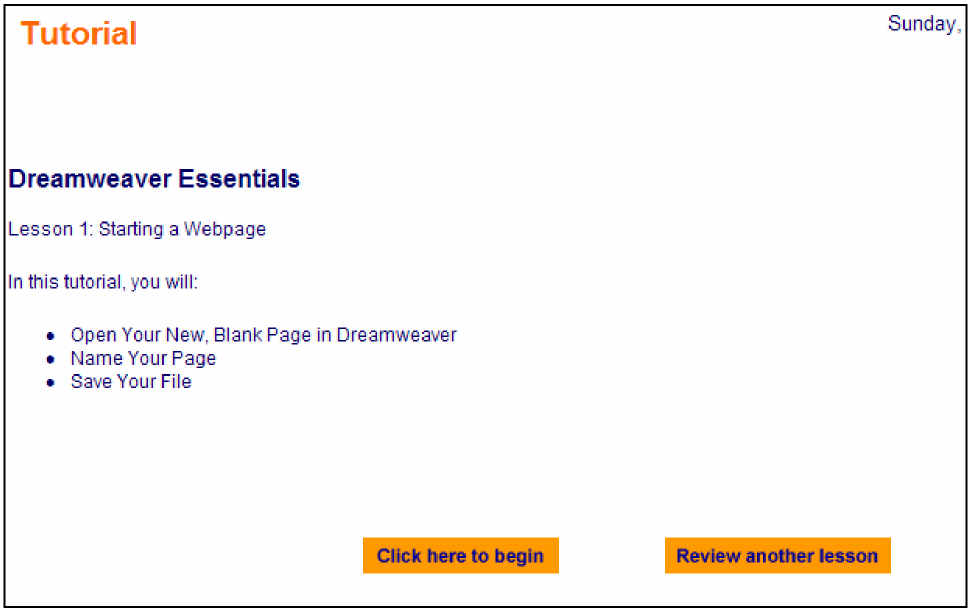
Design	1	2	3
Can you contact the author via e-mail?	No e-mail address link given	Incomplete e-mail address link given	E-mail address link given
Does the information look useful?	Not useful	Might be useful	Sure to be useful
Do the links work?	All dead links	One or two dead links	No dead links
Is the text readable?	Cannot read at all	Very hard to read	Can read it all
How is the “look” of the sight?	Hard to use	Okay	Really helps me find what I need
Total Score in Each Column			
TOTAL SCORE	**/15**		

APPENDIX G: Screen Shots of Controlled and Older-Adult Centered Training

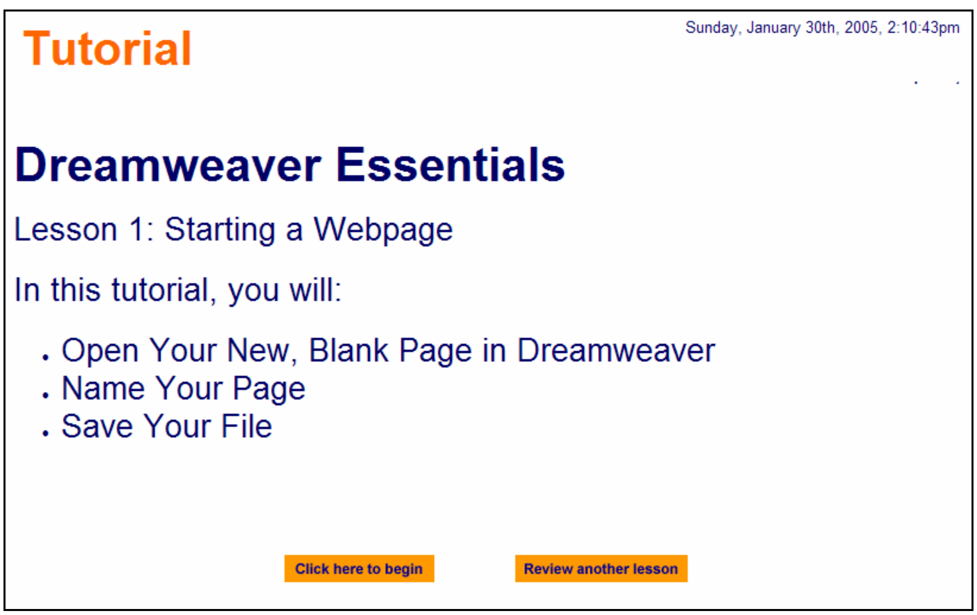
Table of Contents Screen (Controlled Training)

Table of Contents Screen (Older-Adult Centered Training)

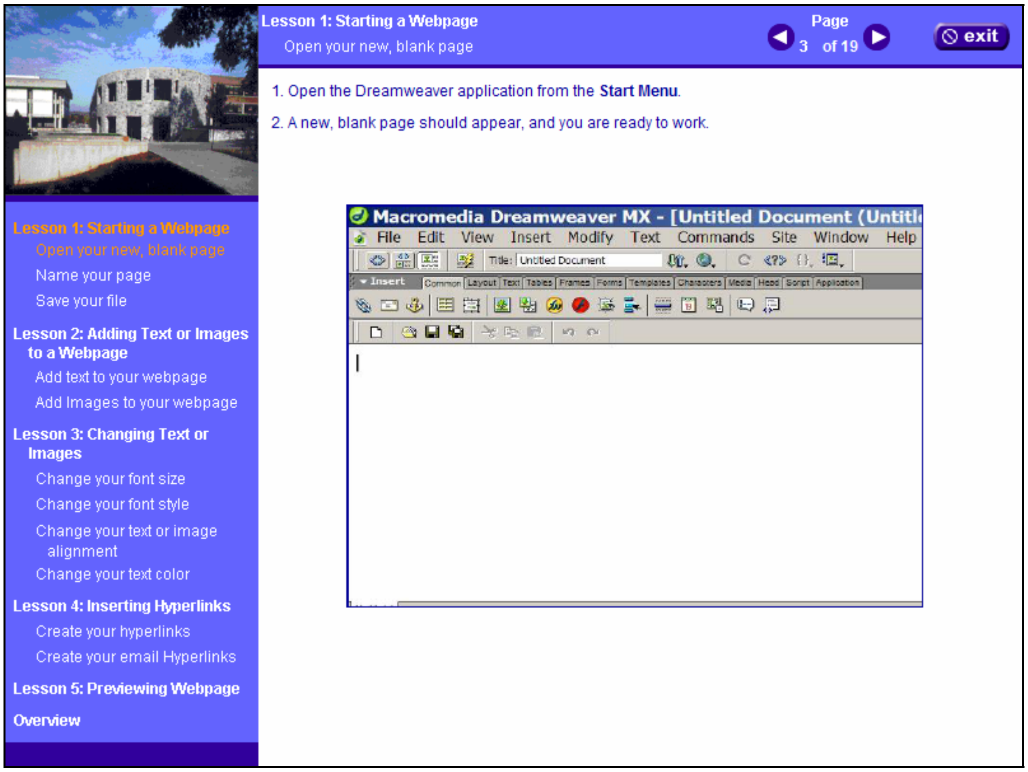
Lesson One Objectives Screen (Controlled Training)



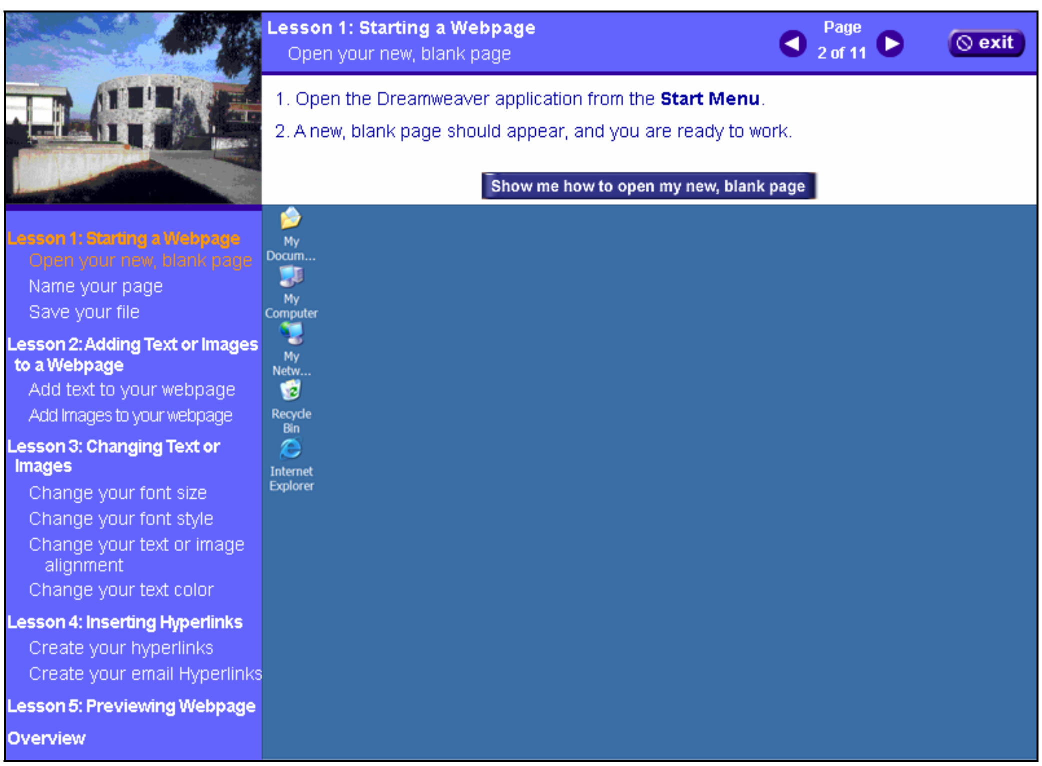
Lesson One Objectives Screen (Older-Adult Centered Training)



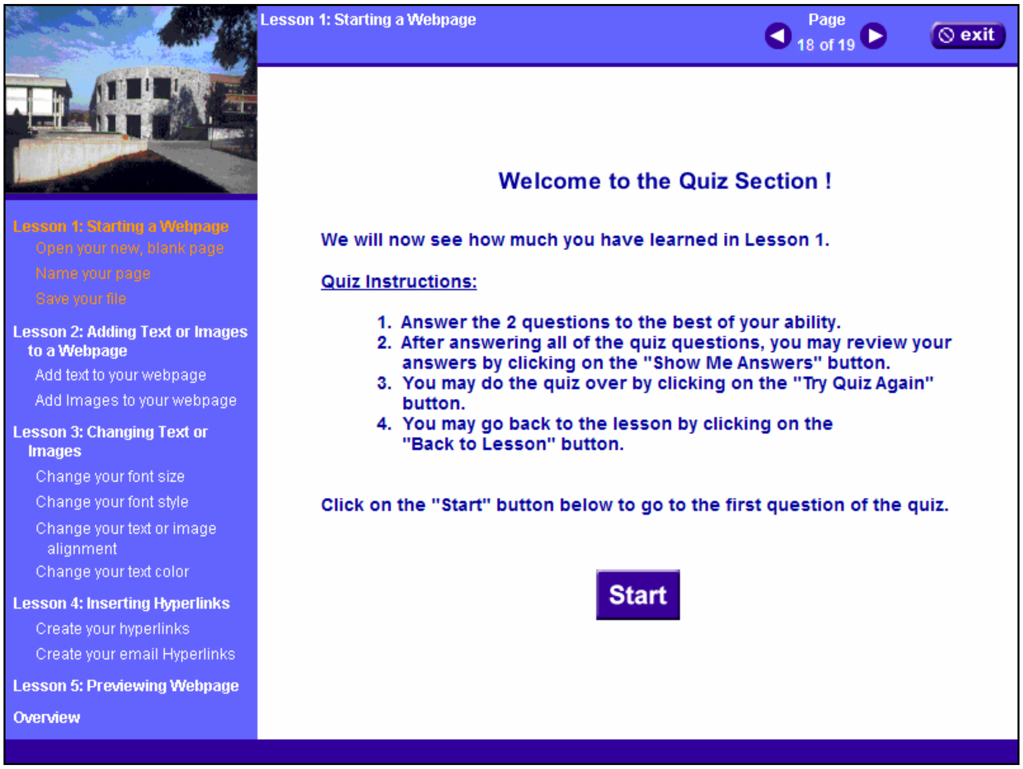
Lesson One Tutorial Screen (Controlled Training)



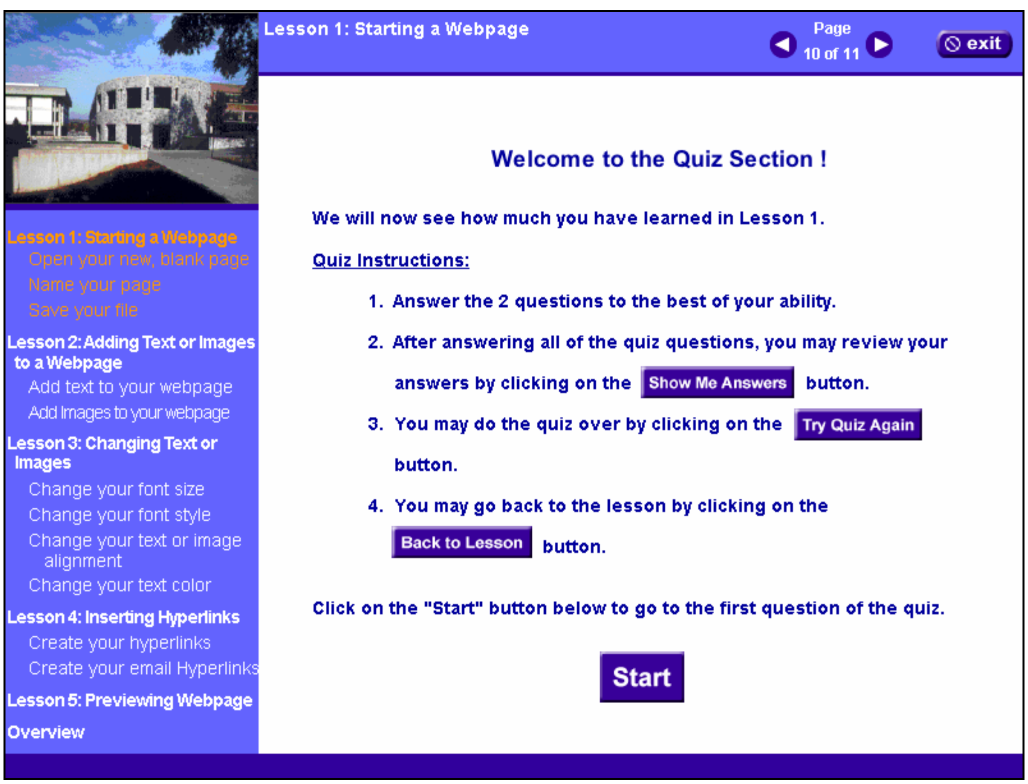
Lesson One Tutorial Screen (Older-Adult Centered Training)



Lesson One Quiz Screen (Controlled Training)



Lesson One Quiz Screen (Older-Adult Centered Training)



APPENDIX H: Fictitious Scenario

COMPUTER APPLICATION

Now that training is over, it's time for you to create your own web page. Please read the entire scenario before creating your web page.

Imagine that you have your own business and you need to create a web page to inform future customers about the services your business offers. Your web page must follow the guidelines below:

- ☐ Put the name of your company (e.g. SA and Associates) centered and in bold font at the top of the web page
- ☐ Create 1 e-mail link so potential customers can e-mail the company if they have questions or need additional information.
- ☐ List at least 2 services (e.g. counseling, advising, tutoring, etc.) your company offers and make these services hyperlinks.
- ☐ Insert at least 1 picture and link the picture to a website. (Pictures are located on the desktop in a folder titled My First Web page.
- ☐ Write at least 1 paragraph (2-4 sentences) stating the purpose and services offered through your business.
- ☐ Put the name of your company (e.g. SA and Associates) in a different color and a larger font size from the paragraph on your web page
- ☐ Before closing your new web page, save your file, preview your website, and print your web page.

For all links, you can use your favorite website or your personal e-mail address for the link. If you do not have a favorite website, you can use a fictitious address such as mybusiness.com. If you do not have an e-mail address, you can use a fictitious e-mail address such as information@mybusiness.com.

Good luck! You may begin designing your web page.

APPENDIX I: Informed Consent Form

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
GRADO DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING
MACROERGONOMICS AND GROUP DECISION SYSTEMS LABORATORY

Informed Consent for Participants of Investigative Projects

Title of Project: Effects of Age, Computer Self-efficacy, and the Design of Web-based Computer Training on Computer Task Performance

Principal Investigator: Sharnnia Artis, Graduate Student, ISE

Faculty Advisor: Dr. Brian Kleiner, Associate Professor, ISE

PURPOSE OF THIS RESEARCH

The purpose of this research is to determine if any distinct age-related differences exist in computer self-efficacy and the way people conduct Web-based computer training.

PROCEDURES

The procedures for the experiment are as follows. First, you will be asked to read and sign the informed consent form for the experiment. Once the form is completed, the researcher will read the training session instructions. Then you will be asked to begin the training program. After completing the training, you will be required to complete the subjective questionnaire and the knowledge assessment. Following the completion of the knowledge assessment and the subjective questionnaire, you will be required to complete the computer application. You will be asked to read the instructions about the computer application section of the study and then you will begin the computer task. After completing the computer task, you will be asked to complete the computer attitude questionnaire.

The session will last about three hours. There are no risks to you. The tasks are not very tiring, but you are welcome to take rest breaks as needed. You may also terminate your participation at any time, for any reason.

RISKS

Participation in this project does not place you at more than minimal risk of harm.

BENEFITS OF THIS RESEARCH

Your participation in this research will be used to help improve the usability and design of Web-based computer training programs. Your participation will also contribute to the efforts to designing WBT programs to accommodate older adults.

BENEFITS AND COMPENSATION

The benefits to you are an understanding of how to create web pages and how to use Dreamweaver® computer software. Additionally, all participants will be paid a rate of $7.00/hour or receive course-credit for participation.

EXTENT OF CONFIDENTIALITY/ANONYMITY

The results of this research will be kept strictly confidential. At no time will the researchers release the results of the study to anyone other than the individuals working on the project without your written consent. The information you provide will have your name removed and only a participant number will identify you during analyses and any written reports of the research.

FREEDOM TO WITHDRAW

You are free to withdraw from this study at anytime without penalty.

APPROVAL OF THIS RESEARCH

This research project has been approved, as required, by the Institutional Review Board for projects involving human participants at Virginia Polytechnic Institute and State University, and the Grado Department of Industrial and Systems Engineering. You will receive a copy of this from to take with you.

PARTICIPANTS RESPONSIBILITY

I voluntarily agree to participate in this study and know of no reason in which I would not be able to participate. As a participant in this study, I have the following responsibility: Answer each question as honestly as possible.

____

Signature of Participant

PARTICIPANT'S PERMISSION

I have read and understand the Informed Consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent to participate in this project, with the understanding that I may discontinue participation at any time if I choose to do so.

Signature: ____

Printed Name: ____

Date: ____

If you have any questions about this research or its conduct, you may contact:

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If you feel you have not been treated accordingly to the descriptions in this form, or your rights as a participant have been violated during the course of this project, you may contact Dr. David Moore, Chair of the Institutional Review Board Research Division at (540) 224-5281.

APPENDIX J: ANOVA Summary Table for Non-Significant Variables

ANOVA summary table for computer self-efficacy.

Source	DF	SS	MS	F	p-level
Age	1	276.13	276.13	1.52	0.229
Gender	1	338.00	338.00	1.87	0.185
Training Type	1	50.00	50.00	0.28	0.604
Age X Gender	1	144.50	144.50	0.80	0.381
Age X Training Type	1	40.50	40.50	0.22	0.641
Gender X Training Type	1	276.13	276.13	1.52	0.229
Age X Gender X Training Type	1	190.13	190.13	1.05	0.316
Error	24	4347.50	181.15		
Total	31	5662.88			

ANOVA summary table for knowledge.

Source	DF	SS	MS	F	p-level
Age	1	0.78	0.78	0.02	0.971
Gender	1	47.53	47.53	0.08	0.775
Training Type	1	2.00	2.00	0.03	0.953
Age X Gender	1	300.13	300.13	0.53	0.474
Age X Training Type	1	195.03	195.03	0.34	0.563
Gender X Training Type	1	38.28	38.28	0.07	0.797
Age X Gender X Training Type	1	24.50	24.50	0.04	0.837
Error	24	13,629.13	567.88		
Total	31	14,237.38			

ANOVA summary table for web page design.

Source	DF	SS	MS	F	p-level
Age	1	3.78	3.78	0.60	0.446
Gender	1	0.78	0.78	0.12	0.728
Training Type	1	0.31	0.31	0.03	0.944
Age X Gender	1	26.28	26.28	4.17	0.052
Age X Training Type	1	1.53	1.53	0.24	0.623
Gender X Training Type	1	2.53	2.53	0.40	0.532
Age X Gender X Training Type	1	3.78	3.78	0.60	0.446
Error	24	151.25	6.30		
Total	31	189.97			

ANOVA summary table for performance error.

Source	DF	SS	MS	F	p-level
Age	1	0.28	0.28	0.09	0.772
Gender	1	0.28	0.28	0.09	0.772
Training Type	1	1.53	1.53	0.47	0.500
Age X Gender	1	0.78	0.78	0.24	0.629
Age X Training Type	1	0.28	0.28	0.09	0.772
Gender X Training Type	1	0.03	0.03	0.01	0.923
Age X Gender X Training Type	1	2.53	2.53	0.78	0.387
Error	24	78.25	3.26		
Total	31	83.97			

APPENDIX K: Personal Vita