DEVELOPMENT OF UNIVERSAL DESIGN GUIDELINES FOR E-LEARNING AND E-TRAINING

by

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ABSTRACT

The purpose of this work is to develop design guidelines for distance education as well as professional training modules considering aging differences as an important factor. A controlled experiment was designed and conducted to evaluate the effects of module design characteristics on information recall, satisfaction, disorientation, and task workload, and the implications for E-Learning and E-Training. Sixteen Web modules with two different lesson content types were developed for this study, considering different independent variables such as camera focus, environment simulator, video size, and instructor's gender. The experimental results revealed significant differences between a wide age range of experimental subjects. Results suggest that different users can be partially accommodated by "Universal Design". Specific preferences in design are discussed when each population segment is individually targeted. Experimental task results revealed that aging adults manage to moderately compensate for their declining cognitive functions even when the design displayed is perceived as visually overwhelming.

RESUMEN

Este estudio se enfoca en el desarrollo de guías de diseño que puedan ser aplicadas tanto a módulos educativos como entrenamientos. Los resultados del estudio experimental sugieren que el concepto universal de diseño no es el más apropiado para los diseñadores en E-Learning y E-Training. Esta conclusión fue obtenida mediante un diseño de experimento controlado que reveló diferencias significativas en un amplio rango de edad de 25 a 65 años. Se plantea el "customization" (diseño enfocado) de los diseños para adultos jóvenes y personas de edad avanzada. Se asocia el concepto de calidad en un módulo educativo como uno que pueda cumplir con los criterios de Usabilidad planteados en la literatura, que permita un alto nivel de retención de información y satisfacción, al tiempo que pueda producir niveles bajos de desorientación y sobrecarga de trabajo ("workload"). Adicionalmente, se presentan guias para cuando la costumizacion no sea una opción de inversión.

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As imperceptible as a second in a day, time passes by quickly and before you know its sunrise once again. For some reason sometimes moving with the change is just as hard as felling captive and wanting to move further on. And it is only in the uncertainty of what to expect or where to go that amazing things happen. I came to Puerto Rico to obtain a Masters Degree and I found family, friends and sometimes love. In this moment of happiness and sense of realization I take the time to acknowledge and dedicate this work to those who made me realize that this journey was more than just a simple academic effort. This journey was also about growing into an independent strong woman and realizing that life is today and happiness can only be assured in a moment. I would like to thank my God because his company made loneliness never concern me during this time away from home. For giving me the strength to climb up mountains and the courage and resistance to continue and reach the goals we planned together. For giving me the wisdom and patience to obey and wait for his time, for being by my side to overcome difficulties and make decisions that today make my family proud. I am grateful for the opportunity the University of Puerto Rico gave me to obtain this degree and I value with all my heart the effort and time the Industrial Engineering department's professors put into the classes so we can become better professionals. Special thanks are extended to Dr. Noel Artiles and Professor Mercedes Ferrer for their support and guidance with the statistical matters of this study. I would also like to extend my profound gratitude to my thesis committee Cristina Pomales Ph.D., Alexandra Medina-Borja Ph.D. and María de los A. Irizarry Ph.D. for their guidance, their trust, their friendship, their patience and unconditional support because it kept me going. I will always be grateful for the honor of sharing these years with your company. I would also like to thank all

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1 INTRODUCTION

Technology is embracing more aspects of day by day activities. Communication, health, business, social activities and entertainment (television, music, virtual reality games, night clubs environments and many others) have had a noticeable change with technology advances. Education and training methods have also changed. It has been reported that enrollment in distance education courses has nearly doubled since 1995, with more than half(56 percent), of two and four-year degree-granting institutions in the United States offering distance education courses in the 2000-2001 academic years (Oliver, 2003). The growth of Distance Learning has not only been evident in the increasing number of students recruited but also in the increment in related publication and journals. Take for example Quarterly Review of Distance Learning, Interactive Learning Environments, Cyber Psychology and Behavior, The Journal of Research on Technology in Education, Journal of Educational Media and many others. Distance learning is a modality by which instructor and learner are separated by time, space or both simultaneously, that began with the Open University's initiative in 1840. Since then, this trend has grown affecting other roles in society. Organizations for example must continually innovate and adapt to the ever-changing knowledge-based environment in which they operate. Consequently, employees are now expected to rapidly gain new knowledge, skills, and abilities to ensure organizational viability and competitiveness. As a result, organizations are turning to training that is unimpeded by time and space. This type of training is known as E-Training (Sims D., Burke C. H., Metcalf D., and Salas E., 2008).

Considering the research and enrollment in online courses, an enormous amount of distance learning courses are being promoted and produced by many universities and private parties. By year 2000 approximately 90 percent of all universities in United States by year 2000 offered some form of distance learning (Pomales and Liu, 2006). Universities such as the University of Maryland, University College have approximately 64% of their total enrolment in their distance learning courses, and online offerings rival those delivered in the classroom.

One major concern arises from the rapid growth rate of offerings and software packages to develop online courses and trainings. These courses are being created based on studies that evaluate a limited number of aspects. Take for example studies evaluating performance, acceptance, quality or satisfaction for a specific group of subjects from an educational area. Perhaps a given course related to the subject's specialization area dividing the population by gender, age, education level and so on. Gottwald (2005) expressed that there is a growing number of studies that focus on a single class, which may be a strong methodological trend or simply a reflection of the convenience of these samples and the ability to control variables within them.

Traditionally, distance learning courses have focused more on students that lived far away from campus, time-strapped "adult learners", and students with difficulties trying to work full-time while earning degrees. The focus of these programs did not include the regular "full

time” student but rather the disciplined type searching for higher education, mostly adults, older than the typical undergraduate student.

The acceptance of distance learning on behalf of aging or the adult population may be triggered by its growth rate. The United States as well as other countries has encountered a complex demographic shift known by many as the baby boomers. Although the concept of the baby boomers was conceived and applied by Americans to Americans it is not limited to those born in the United States. The boomers enclose all the born during a period of increased birth rate after WWII and before the Vietnam War (1945-1959). The special importance given to these subjects is the proportion of individuals composing the actual workforce under this category who may not be sheltered in today’s Web instruction application designs. Rau and Hsu (2005) cited in “Interaction Devices and Web Design for Novice Older Users” that according to the U.S. Census Bureau (2003) the population 55 and over is around 35 million. There are approximately 70 million baby boomers in the U.S. working force and the Bureau of Labor Statistics (BLS) predicts that there will be 55 million older workers 45 years of age by year 2015 (Kowalski-Trakofler, K.M., Steier, L.J., Schwerha, D.J., 2005). These numbers represent about 12% of the total population and approximately 40% of the working force. Furthermore, by year 2030 the annual percentage increases in the older (65 and over) population will outstrip the increase in the general population by three to four times, and the number of individuals that will be older than 65 years will more than double 71.5 millions of people.

All statistics above show a fast growing and influent population for whom today's Web instructional modules may not be appropriate.

Attending instructional design needs for the continuously growing population within the academic and work areas represents a challenge. One of the approaches that can provide a feasible solution to the perhaps inappropriate designs for the aging is universal usability. This concept is one proposed by Norman (Norman, 2004), meaning "barrier free". The concept of universal design suggests that one design would include and accommodate older and less experienced users and simultaneously younger and more experienced users. Although this might sound as a perfect solution in the search of accommodating an aging population, there is also the belief that this is not much more than a utopia, "impossible", and that designers must target a specific population (Hawthorn, 2000). Then again, it should be said, this last statement may be erroneous because a common practice when designing for older adults is building a restricted interface or computer environment to eliminate misunderstanding and the execution of undesired actions, when the goal should be to use natural constrains this is, common life restrictions (Burrell and Sodan, 2006).

This research intends to determine universal design guidelines that can be applied when designing online courses for a 25 years old learner, as well as for one 65 years of age. The goal is to ensuring high level of, satisfaction and information recall while maintaining low levels of disorientation and task workload.

1.1 Motivation and Justification

"Technology presents a great deal of opportunities for developing education and training. Specially, audio and video communication technologies have become useful tools for extending the research of training and staff development. Unfortunately, many of these opportunities are missed due to the lack of technology adoption and assimilation" (Rau and Hsu, 2005).

A possible cause can be revealed taking a closer look at the statistics exposed in the introductory section and observing the tendency of today's U.S. growing aging workforce. The United States as other countries have encountered a complex demographic shift in population aging. This combined with a persistent use of computers reveals an imminent necessity to understand the influencing factors of aging in relation to the design of learning interfaces. Technology has altered the way aging individuals carry out their daily activities. They have been driven to include technology, computer and internet use in many aspects of their everyday activities, to visit Web pages for personal purposes (shopping, emailing, news paper and magazine reading) or continued professional education (distance learning courses, master level programs, doctoral programs, trainings, and others). Even though, most Web pages and sites seem to be oriented to a young and technologically savvy generation.

While there is certainly a population that has grown in tandem with technology (touch screen devices, voice recognition devices and others) which are young and computer experienced, there are others that do not share the same common ground and computer experience, the aging (baby boomers and older adults). This disadvantage when combined with a large amount of physical and cognitive declining functions of the elderly, may difficult the adoption and assimilation of technology. Therefore, making questionable the effectiveness and quality of E-Learning and E-Training modules for this special age group.

Therefore, it is possible to affirm as stated in Chapter 1, that there are approximately 71.5 million reasons to write about this subject, why it should be out spoken and carefully studied. More than twice is the number of predicted aging individuals by year 2030. Furthermore, there are an increasing number of online courses as well as companies training their employees online. Take for example, the Red Cross, Hewlett-Packard and institutes and colleges offering distance learning courses. Every year companies positioned in the top 10, according to Fortune's annual ranking of America's largest corporations in 2008, spend millions of dollars in training their human resources. One study suggests that companies ranging in size from 500 and 25,000 employees spend between $88,400 and $1.2 million annually on technology to manage and distribute training (Sims et al., 2008), suggesting a significant cost in supporting employees' learning.

The real question here that remains unspoken is what can be said about the efficiency and quality of the designs employed. Some say, “The investment has paid off”. Organizations have reported positive results on their efforts related to the design of E-Learning courses and technology required to support them (Sims et al., 2008). The real price of this positive response is a very high customization of trainings and E-Learning course design and still, this may not assure user satisfaction or efficiency of the design interfaces.

1.2 Objectives

The main purpose of this research is to conduct a controlled experimental study to develop design guidelines that will provide effective and quality educational modules. The results of this study will help develop modules that will provide high user satisfaction and information recall, while maintaining low levels of disorientation and task workload. These experimental instructional modules refer to E-Learning courses and specialized training modules (E-Training) that can be applied to a wide range of technical areas and individual ages in universities, continuing education programs, and in the service and manufacturing sectors.

To accomplish the proposed objective the following questions should be answered:

1. Is it possible to have universal design guidelines for E-Learning and E-Training modules that target young and aging populations simultaneously?

2. How do filming techniques employed in professional television production (Camera Focus, Background Simulators and Video Size) affect user response (Information Recall, Satisfaction, Disorientation and Task Workload) when adapted to the video in the learning interface?
3. From which source of information in the experimental module interface does the individual recall more information?
    a) Information transmitted through narration by the instructor in the module video
    b) Information transmitted through a banner in the module interface
    c) Information transmitted through a PowerPoint presentation in the module interface
4. How are experimental variables (Information Recall, Satisfaction, Disorientation and Task Load) affected by the instructors' gender?
5. How layout arrangement preferences change based on lesson content type (numerical compared to narrative information)?

1.3 Literature Review

"Barrier free" is a relatively new paradigm that emerged from the idea of making things accessible to provide equal opportunities of use, assimilation and understanding for all individuals regardless of their physical or psychological limitations. This concept is known to many as universal design.

The imperceptible process of aging, accompanied by the declining functions that occur with time, can also be seen as disabilities and therefore are not different from any worthy challenge for a designer with a universal approach.

Nowadays it is possible to see the universal design tendency for example in entrances without stairways, large letter labels in products, among others. Many design guidelines have been created to provide designers with appropriate criteria to create more inclusive designs. In this study these existing criteria will be employed as a start point to develop the experimental modules. This strategy will help standardize criteria and evaluate how they work in conjunction.

Design criteria to develop Web-based user interfaces such as distance learning modules, E-Training modules, have been divided in this study as following three major approaches for better understanding: (1) appearance, (2) structure and (3) physical interaction.

1.3.1 Appearance and Aesthetic Characteristics

Appearance makes reference to headings regarding, text size, colors, position (Hartley, 1994; Weale, 1961); Text size and Type (Sorg, 1985; Bernard, 2002; Bernard and Mills, 2002; Pomales and Liu, 2006); backgrounds and text color (Wolfmaier, 1999; Weale, 1961; Gould and Schaefer 2005; Scharff, Hill and Austin, 1996; Bauer and Cavonius, 1980; Charness and

Bosman, 1990; Tobias, 1987); contrast (Kline and Schieber, 1985); also labeling, positioning and size of hyperlinks (Troung, Huang and Stevens, 2004; Burrell and Sodan, 2006; Bernard, Liao and Mills, 2001; Knoved and Shneiderman, 1986; Nygren and Allard, 1996; Maldonado and Resnick, 2002; Bernard and Hamblin, 2003; Bernard, Fernandez and Hull, 2002).

Aesthetic characteristics have been classified in four design attributes: (1) headings, (2) text size and type, (3) background, text color and, contrast and (4) hyperlinks. The literature suggests that *headings* should be as clear as possible (Hartley, 1994) as they serve as indexes or maps. When headings are used as maps or routes and convey the relevant information that a user should target on a Web page they serve two main purposes. First, headings spatially orient users and second, they avoid the annoying sensation of feeling lost in the page specially when overloaded by advertisements or unnecessary images and graphics. During the aging process the biological structures that bend, transform and guide light change, causing a reduction in the amount of light reaching the retina and defocusing the image projected to the retina (Weale, 1961). There is a reduction of 50% in the amount of light perceived at age 50 compared to 20 years old, increasing to 60% at 60 years old, and these changes in visual perception become relevant when designing headings

The text size and type is another important aesthetic characteristic. Changes in the visual field are tied to many, physiological and psychological processes that develop with age (Kline and Scheiber, 1985). Regarding type of letter, Boyarski, et al. (Boyarski, 1998) discovered small but higher levels of comprehension for the Georgia font over Verdana in

computer screens, while comparing serif and sans serif letter type. The present study included in the serif type letters, Georgia and Times New Roman and in the sans serif letters Arial and Verdana. In addition similar results are also supported by Sorg (1985). Bernard et al. (2002), pointed that older adults prefer and tend to be more accurate with sans serif and large fonts (comparing sizes 12 and 14). Similarly Pomales and Liu (2006) found that Web modules with color words in slides with text and text font size 14 had higher ratings of simplicity, visual attractiveness, organization, clarity and excitement in a population between 18 and 22 years old.

Background in an interface is a design attribute that has been studied in developing interfaces. Research suggests that 4% of internet users are color impaired in someway (Wolfmaier, 1999). When aging, it is common to see cataracts and dimmed light veiling, changes in the vitreous humor (this is a clear gel that fills the space between the lens and the retina of the eyeball) may yellow, increasing the problems of color perception as white objects appear yellow. Blue and green therefore are difficult to distinguish, cloudiness and alteration in the integrity of the macular (center area of the retina which provides detailed central vision, called fovea) pigment and neural pathways (Weale, 1961). Blue is considered to be the most subtle color, while green has been found to attract the human eye. These two colors are usually used to represent active or inactive options (green and blue respectively) (Gould, 2005). Scharff et al. (1996) sustain that plain backgrounds rather than textured in waves and cultured styles deploy faster search times such as having a higher contrast between background and letters (Scharff et al., 1996). Using white may not seem a big issue when

designing for young users but as people age there is an increase of sensitivity to glare, reason why, pure white is not recommendable. Charness and Bosman (Charness and Bosman, 1990) found that colored text slows down performance compared to Black and White combination.

Tobias (1987) affirmed that black letters and white background is the optimum combination for Web design (Tobias, 1987). As the aging process advances vision adaptation to different light levels takes longer. There is a reduction in the perception of *contrast* and a decrease in the ability to focus at different distances. Precision becomes a very hard task especially if the object is moving fast or elevated (Kline and Scheiber, 1985).

Labeling, position and size are important aspects specially when considering hyperlinks. When labeling, by employing metaphors, it is possible to make users think-out processes as the real world situations and not computer- based, thereby, minimizing confusion (Troung et al, 2004). Hyperlinks should follow a proper sequence of labeling from level to level. Aiming standard size and spacing between hyperlinks was found to be an issue for older individuals because of the vision declining effects of aging. Similar to headings, hyperlinks are routes to guide users through the Web page to the objective of use. In this manner making hyperlinks as accessible as possible is of relevant significance. Links have better market effect on columns than in rows (Nygren and Allard 1996). Expandable menus decrease speed (time, errors) compared to bread crumbs (Maldonado and Resnick, 2002). It is also preferable to have them in categories rather than ordered alphabetically as it is harder guessing the name in order (Bernard et al., 2003). When possible, links should be presented in one page only,

using expandable or roll over techniques reduces link crowding on screen (Bernard et al., 2002). All above may suggest that in cases in which employees or students must select from a group of training or courses, the expandable and category arranged menus are first choices.

1.3.2 Structure

With regards to the Web Structure, in 1996 Forsythe affirmed that 58% of navigation errors were caused by being lost in structure. By year 2006 evidence supports that Webs should be like physical maps that have landmarks to support constructing cognitive maps (Burrell and Sodan, 2006). Within the concept of structure, the field of view becomes important because the information that is desired to be targeted by users will have a restricted area to choose from and place information in a balanced, stabled, equilibrated and sequenced order (Hawthorn, 2000; Plude and Hoyer, 1981; Ngo and Byrne, 2001; Benway and Lang, 1998; Cho, 2003; Poynter Institute Report, 2000).

1.3.3 Physical Interaction

Finally physical interaction is also considered as a relevant design criteria because computer interaction changes at different ages during normal aging process. Decision making process, attention capacity (concurrent activities, competing displays of information), memory decreases (capacity of remembering how to execute a certain task), fine motor skills lose precision (scrolling and clicking) varying in tandem with the aging pace. In this manner,

proper feedback (sounds, lights, messages, alarms, images) should be included in designs to compensate for the physical and cognitive deficiencies an aging user might experience and enhance the learning experience.

Although elements in the three design criteria described above (appearance, structure and physical interaction) as grouped in this study for better understanding have been studied independently in different age groups and are known to be vital when designing a distance learning module or a training module, they have not been tested yet simultaneously in a single module across a wide age range population. Because important aging considerations are contemplated for modules developed in this study, it was expected to find that satisfaction levels would be higher or equal in older adults compared to younger users because of the adequacy of the resultant interface design. Even though, it is important to state that this study did not intend to design an adequate learning and training module for older users but for a larger population in an age range between 25 to 65 years old, focusing in the universal approach. Table 1.1 summarizes relevant design criteria adopted in addition to the design variables under experimental study.

1.3.4 Summary of design criteria

Table 1-1 Summary of Design Criteria by Categories

Design Criteria Summary				
Cat	**Attributes**	**Elements Observed**	**Applied to interface**	**Literature Review (Authors)**
Appearance	Headings	Text, size, colors, position	Letters 22+, Black font, aligned to the left.	Hartley1994, Weale1961
	Body Text	Size, type, length	Letters 22+, Arial and Georgia, less than 60 characters per line.	Sorg1985, Kline and Scheiber1985, Boyarski1998, Bernard and Mills2002, Pomales and Liu 2006.
	Background, Contrast	Color and color vs. text color	Letters Black and Midnight blue and white for banners. Background Light gray and smoke white.	Wolfmaier1999, Weale1961, Gould2005, Scharff1999; Bauer1980, Charness1990; Tobias1987, Kline1985.
	Hyperlinks	Labeling, positioning, size, length	Center oriented, 22+, use of metaphors, single word description.	Troung2004, Burrell2006, Bernard2001, Knoved1986, Nygren1996, Maldonado2002, Bernard2003, Bernard2002.
Structure	Hierarchy	Application depth	Wide rather than deep.	Norman1988, Mead1997, Larson1998, Kim2000
	Field of view	Balance, stability, sequence, equilibrium	Center oriented screens, margins larger than 3’’.	Forsythe1996, Burrell and Sodan 2006, Hawthorn2000, Plude1981, Ngo2001, Benway1998, Cho2003, Poynter Institute2000.
Physical Interaction	Decision making, Attention Capacity	Concurrent activities, competing displays, reaction times, attention span.	Content was precise, and interface information sources complement verbal instructions. Feedback effects recaptured attention in every chapter.	Snel1994, Cho2003, Vericriuyssen1994, Hawthorn2000
	Memory decrease	Short term memory and long term memory.	Use of previous and error prevention messages to avoid relaying on memory rather than recall.	Kowalski-Trakofler2005
	Fine motor precision	Scrolling, clicking	Interfaces required no scrolling. Clicking aiming big targets.	Hawthorn1998, Casali1992
	Feedback	Sounds, lights, messages, alarms, images.	Lights, and images, and window loading effects.	Hawthorn2000

1.3.5 Dependent measures

Under this perspective, in the search for a universal design approach, information recall, satisfaction (Cook, 1991), disorientation (Beasley and Waugh, 1995) and task workload (Hart and Staveland, 1988) will be measured for every experimental module. These four measures (recall, satisfaction, disorientation and task workload) represent the dependent variables in the controlled experiment designed for this study. These variables may complement one another depending on how the construct is defined in the study. Take for example task workload and satisfaction; high levels of satisfaction may suggest that the individual exposed to a certain module had also low levels of workload. In this study, the satisfaction construct will target mental aspects of the work such as “boredom”, “mental effort”, “independent thought” and “challenge”. Some satisfaction questions point directly to what participants feel regarding specific aesthetic features. Task workload on the other hand, intends to collect information about the overall experience of viewing and evaluating the course module. Although both satisfaction and task workload represent subjective measures closely related to each other, the question that would be answered with the task workload construct is how much resources did this task required instead of what is the participant’s felling regarding a specific aspect of the module such as content, video size and others.

Although some uncertainty surrounds the concept of task workload, in this study as in Cook's (1991), it will be understood as a concept associated to task demands and the mental resources to perform the task goals. Declining functions natural to the aging process discussed previously may decrease the ability to fulfill demands on working memory due to time sharing, information quantity and perceptual and central processing.

Disorientation is expected to measure user awareness. This construct is composed by 10 items that measure feelings of the learner such as confusion, easiness, comfort, organization and mental structure of the lesson content and uncertainty. All these concepts became relevant because the prediction in the sample selection was that a very high percent of older users, and young and more technology experienced users at the University of Puerto Rico may have never been exposed to this type of education. The purpose of this measure is to understand possible behaviors and feelings sustained by the participant through the experiment while viewing the instructional modules.

Information recall is the last of the four dependent variables to be described. It serves as a tool to identify if participants are engaged and paying attention to the learning modules. A study by Pomales and Liu (Pomales and Liu, 2006) affirmed that this measure can be used to understand if different design attributes have an impact on the amount of information people remember after being exposed to a learning module.

That study revealed that modules with video show a difference in the number of phrases recalled than those modules presented without video.

The present study aims to understand if information recall (amount of information an individual can recall or retain in a short period of time) changes with different module design characteristics, all which include videos and teach two different topics. Additionally, what kind information does the individual retain whether it is what is narrated by the instructor, the banner content or the PowerPoint presentation content presented in the module.

It is possible to have an individual who reports low levels of workload and be dissatisfied or disoriented with or by the process of viewing and evaluating the instructional module. All four dependent variables (recall, satisfaction, workload and disorientation) were selected to understand how the aesthetic-design characteristics impact the user and the implications for learning and training.

Learning styles of the participants in the experiment was also measured to describe the sample and understand if this measure holds a relationship with the dependent measures and individual responses. The concept of Learning Styles is related to individual preferences for receiving and processing information. Learning styles are known to influence the ways that learners attach their own meanings to the topic taught (Roy, 2006). They have been evaluated

in relation to efficiency and effectiveness of E-Learning. Roy (2006) studied the impact of learning styles on interactivity in asynchronous E-Learning. She found that interaction is a tool used to keep people awake, alert and their brain working, increasing the level of retention (recall) of class content, but did not find that learning styles made a difference in asynchronous E-Learning. Hong (2002) also reported the same result describing that there is no relationship between learning styles and learning achievement (Roy, 2006). Although very important, these studies may suggest not submerging into learning style impact and effects.

This work does not intend to design purposefully for different learning styles either; but the different module designs attempt to fully meet the need of any group of learners more than to simply expand the body of knowledge with respect to learning styles and Web based courses or E-Training design characteristics. Learning styles will be measured with Felder-Silverman Index of Learning Styles. Most other learning style models classify learners in few groups, whereas Felder-Silverman describes the learning style of a learner in more detail, distinguishing between preferences in four dimensions. In addition, the Felder-Silverman model is based on tendencies, stating that learners with a high preference for certain behavior can also act sometimes differently. According to a study by Carver, Howard, and Lane, (1999), “the Felder-Silverman Index of Learning Styles is most appropriate for hypermedia courseware” and it can also be seen that this instrument is used very often in research related to learning styles in advanced learning technologies”. Finally short term memory will be

addressed with a simple recall question to ensure that at least knowledge of the content presented in the learning module is achieved, following Blooms Learning Taxonomy.

1.4 Summary of Following Chapters

Chapter-1 presented an Introduction that intends to build the necessary background to understand the problem, followed by the Problem Statement in Chapter-2. Chapter-3 describes the Methodology followed by Data analysis and Results in Chapter-4. Chapter-5 exposes the study's Conclusions, and Chapter-6 contains the Discussion. Document continues describing in Chapter 7 Future Work and the Research Contribution. In addition to these chapters several appendixes can be found with the evaluation questionnaires for the dependent variables, full transcription of participant commentaries and snapshots.

2 PROBLEM STATEMENT

Because the main objective of this study is to develop universal design guidelines for E-Learning and E-Training, the instructional modules developed consider aging population needs as part of their design criteria. The design criteria take into account, letter type and size, color, contrast and others further along discussed in more detail. An aging individual in this study is considered as defined by the Age Discrimination and Employment Act (ADEA) as any individual over 40 years old. Dirken (1972) spoke about a separation in human aging.

The first aspect is the functional age followed by the chronological age. Chronological age is taken as an index to measure the aging process of an individual. Functional age refers to how well a person can function in a certain environment compared with other people of the same chronological age.

In the aging related literature, several learning theories can be found. They can be divided in two groups: (1) biological declining functions (Cronholm and Schalling, 1988; Burke and Mackay, 1997; Rabbitt and Lowe, 2000) and (2) accumulation of knowledge (Westerholm and Kilborn, 1997; Kowalski-Trakofler et al., 2005). The first group affirms that the decline in biological functions affects the ability to learn and to perform many work related tasks. The second half suggests that the accumulation of knowledge and experience leads to an increase in skills with age. Others (Colley and Beech, 1989; Bruyer and Scailquin, 1994) believe that perhaps there is not enough information to determine a definite answer. Moreover, with age there is a reduction in functions, both physical and cognitive. As part of the physical functions, vision, hearing, balance, manual dexterity, reaction times, joint mobility, muscular strength, aerobic capacity, and endurance experience drastic changes. According to Czaja (1996), cognitive functions decline producing changes in the attention process, working memory capabilities, discourse comprehension, inference formation, intelligence, language, and information processing speed. These changes may impact the ability of older adults to acquire new skills. Most of these changes are generally considered to be noticeable at a chronological age of 55 years.

While aging, reaction time increases making difficult the decision making process. Stimulus/Response relations are indirect or not logical (Kowalski-Trakofler et al., 2005). Part of which makes computer interaction different for older adults. Also, attention capacity (Snel and Cremer, 1994; Cho, 2003) and attention span in older adults is very reduced (Vercruyssen, 1994). After age 55 the ability to divide attention between tasks declines, as well as attention capacity. Thus, it is difficult to perform concurrent activities with competing displays of information. Hawthorn (2000) affirmed that older adults get very distracted by visual noise, backgrounds and graphics. Simultaneously, they seem to need more feedback, sounds and lights around links, and change of images with mouse pointer to select or when clicking. Standard size hyperlinks present difficulty for clicking. Reason why Hawthorn (1998) stated that fine motors skills also tend to decrease and as a result, precision of mouse may be affected. As older users struggle with movement, moving in straight lines, navigating over small spaces, clicking small targets, and color differentiation becomes more challenging. Casali (1992) found that small targets were problematic for physically impaired users in a dragging task. Also scrolling becomes uncomfortable just as a large number of consecutive clicks. Although clicking is preferred to scrolling for ergonomic reasons (size of mouse button to scroll and the required movement), aiming objects to select and click also becomes a journey for older adults. Following these issues, it is recommended that icons and links should have a clear space between them to reduce precision and vision requirements to select. Based on these characteristics, the interfaces developed for this study will require no scrolling.

It is evident that communication, technology, globalization and accessibility changes have produced a different and almost strange environment for the aging, compared to the world they experienced as they grew up. Reflecting on the statistics presented in Chapter 1, it is important to remember the number of active (working) boomers who are driven by technology changes and forced to assimilate its inclusion in many aspects of life through the use computers and internet. Perhaps under this bundle of ideas consideration for appearance, structure and physical interaction, have been studied in a separate manner. However, making letters more readable and designing in a way that does not require the users to remember every detail to execute a certain task may not assure efficiency of the design by itself. In practice, design strategies such as simplifying screen layout and incorporating high contrast have augmented older adults limited processing resources, inability to filter out noise in perception and specific sensory deficits providing benefits (Jacko J. V. et al., 2004).

Customization is another alternative to reach a wide age range segment of young and aging adults in design allowing users to accommodate interface aesthetic aspects and hardware. Although convenient, this is a very costly design approach. In this sense, it is relevant to ask what is the best alternative to design E -Learning courses or E-Training modules for young and aging individuals? How should E-Learning modules be designed to improve satisfaction, information recall, low levels of disorientation and mental overload? Up to date these are questions remain unanswered by controlled and systematic experimental methods.

3 METHODOLOGY

A controlled experiment was designed and conducted to evaluate the effects of module design characteristics on information recall, satisfaction, disorientation, and task workload, and the implications for E-Learning and E-Training. Sixteen Web modules with two different lesson content types were developed for this study, considering different independent variables such as camera focus, environment simulator, video size, and instructor's gender.

In addition, participants completed two additional tasks. Prior to viewing the content modules each participant arranged the interface layout to their preference and at the end of the experiment then valued their experience by selecting and ranking from a set of words and shared commentaries of their experience. The experiment will be presented in detail in the following sub-sections.

3.1 Participant Characteristics

Sixty four (64) individuals from two different age groups (25 to 35 and 55 to 64 years of age) participated voluntarily in the study. In each group of 32 participants, sixteen (16) were females and sixteen (16) were male. Participants were students, active employees of the University of Puerto Rico at Mayagüez, and local retired individuals. None of the participants received compensation for participating in the study.

In addition, Learning Style evaluations of the participants revealed that the majority of participants were active, sensing, visual, and sequential following the learning style categories established in the Felder-Silverman model (Figure 3.1).

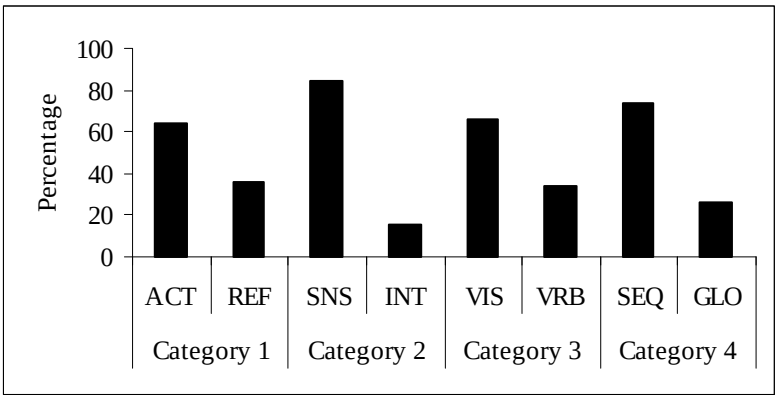

Figure 3-1 Learning Style Description by category

The Felder-Silverman model suggest that active learners tend to retain information and understand best by doing something active with it discussing or applying it or explaining it to others, instead of thinking about it quietly first which corresponds to a Reflective learner. The ideal condition is to have a balance between both. Reflective learners represent 35.9% of the total participants and active learning style fits approximately 64.1% of the study population. 21.9% of these present a strong preference for active learning style, while 43.9% have a moderate preference and 34.2% are balanced within active and reflective style. This is conveniently positive because participants were required to complete a series of tasks, in some cases with little or no previous experience. More specifically, 28.1% of the study

sample had less than 5 years of computer experience perhaps making basic computer interaction limited and difficult. Moreover only 6.3% has had the opportunity to experience web based distance learning. In addition, most participants did not need an extended amount of time to engage in the required tasks nor were they shy to interact with the module by "trying out" all options that seemed to lead them to a better understanding of the requested experimental activities.

According to the Felder-Silverman Model, sensing learners tend to like facts. They often like solving problems by well- establishing methods and dislike complications and surprises. Sensing individuals are more likely than intuitive individuals to resent being tested on material that has not been explicitly covered in class. Sensing individuals tend to be patient with details and good at memorizing facts and doing hands-on (laboratory) work. Intuitive learners on the contraire prefer discovering possibilities and relationships, they like innovation and dislike repetition (conveniently for this specific experiment). Sensing represent 84.4% of the studied population while intuitive 15.6%. Within sensing 44.44% present a strong preference for this style while others define their preference as balanced and moderate (20.37% and 35.19% respectively).

Higher preference for the sensing learning style over intuitive could be ideal in this experimental study and it may influence positively the dependent variables such as satisfaction, disorientation, task load and information recall. This is because the experimental

modules expose facts regarding two different subjects and the experimental procedure was clearly discussed, and supplementary time for questions was provided leaving no chance for surprises. The experimental procedure was somewhat repetitive (disliked by intuitors) as it required participants to view four modules with different design characteristics and the same content. In addition, information recall was evaluated through an open question for which participants did not necessarily have to memorize content. This helped avoid any questions that participants may feel not explicitly exposed or discussed.

Visual learners remember best what they see. 65.5% of the sample reported to be visual learners, within which 47.62% presented a moderate preference for this style, 30.95% of the participants have a strong preference, while 21.43% were balanced. Verbal learners represented by 34.4% of the total participants, tend to capture easily written and spoken explanations.

Sequential and global learners complete the learning styles categories defined by Felder. Sequential learners tend to gain understanding in linear steps, following logically concatenated steps. Global learners tend to learn in large jumps, absorbing material almost randomly without seeing connections, and then suddenly “getting it”. This last category fits approximately 26.6% of the population studied. Sequential learners represent 73.4% of the participants who volunteered in this study. 12.76% of these have a strong preference, while 48.93% and 38.29%, were found to have a balanced and moderate preference respectively.

3.2 Equipment and Materials

The experiment was conducted in three different locations. The Human Factors Laboratory at the Industrial Engineer department at the University of Puerto Rico Mayagüez campus, and in an executive conference room at the Human Resources department in the same institution served as the main testing locations. Rooms were accommodated to perform experiment activities. Accommodations included two (2) Dell computers, laptop and desktop type. These were connected in order to provide the necessary resources that enable the instructional module server, data base, and Morae usability software to function adequately in the desktop computer. The Morae software enabled an observer station to monitor participants through the testing procedure. The laptop computer also provided a viewer remote application provided by the usability software installed in the desktop computer. The participant station included a desktop Dell computer (with Windows XP, Morae usability software and a 17" screen with resolution of 1024 by 768 pixels.), headphones (noise blockers) or speakers as per participant choice, a microphone, Webcam, mouse and keyboard. The station also included two separate desks where both computers were placed and two chairs for the participant and the investigator.

3.3 Web Module Design

The instructional module interface was designed for the experiment and coded in Java and JavaScript. Each module had four different types of interfaces. The first screen corresponds to the registration interface; the second screen had the layout selection screen, then the experimental Web module and finally the questionnaire (user response) screens. Figure 3.2 shows the registration interface that each participant used to login and start the experiment. The use of metaphors in the registration interface helped participants understand instructions by looking at related images. For example, an image of an identification card was used to represent the concept of personal identification.

Figure 3-2 Screenshot of the Webpage used as the registration interface.

After the login in the registration interface, the participants were allowed to choose the layout of their preference to view the Web module, and immediately were able to see the screen layout preview at the right side of the screen (see Figure 3.3). The image of the desktop computer screen is another metaphor used to help participants understand instructions by previewing their actions. In Figure 3.3, the image labeled as “Desktop computer screen” (it literally resembles the label) was designed to help participants visualize the location of the module video. As each participant placed the video icon over any four positions in the computer screen image they were able to preview the final composition or layout of the Web module. In the example shown in Figure 3.3, the right upper position (RUP), left lower position (LLP) and right lower position (RLP) are empty positions where participants can place the video to view the training or Web course. The “Course interface” image presents a screen preview of the final arrangement of the Web module components based on the participant’s selection of the video position. This image serves as a visual aid to help participants understand and see the exact place where the video will appear. Images contained in the preview or “Course interface” image give the participant an idea of how the experimental course interface will be seen.

One of the known difficulties of navigating Web pages is the “art museum effect” where too much information is presented overwhelming the user and decreasing information recall. When instructions or directions are not clear, people may tend to be confused. According to Burrell and Sodan (2006), Web applications should not be like common physical maps, they

should have landmarks to support constructing cognitive maps. Accounting for the aging process, it is understood that as people age, vision decreases and the vision angle becomes more restricted. In consequence some studies have supported the idea of targeting important information on the center of the screen, rather than the periphery (Hawthorn, 2000; Plude and Hoyer, 1981). In this study the design interfaces groups the lesson content at the center of the page, therefore leaving a margins of approximately up to 3 inches.

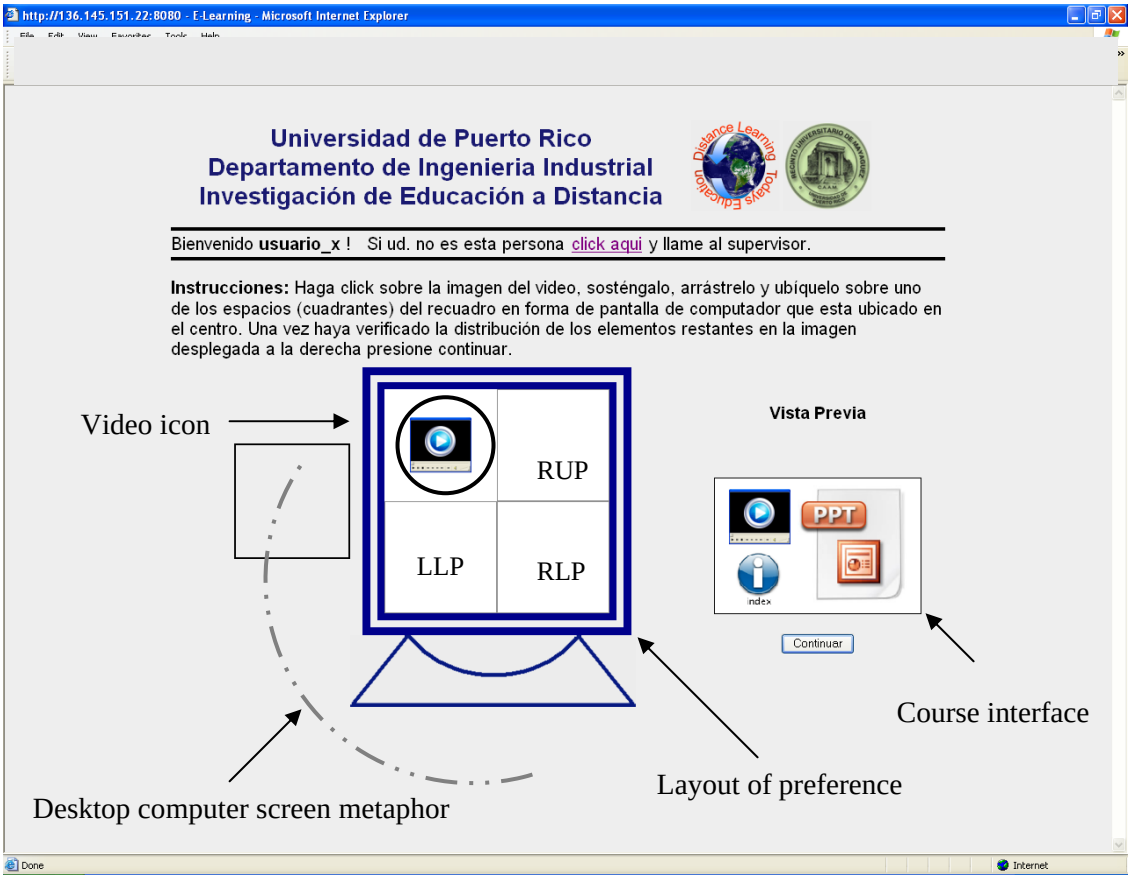

Figure 3-3 Layout selection screen.

However everything cannot be placed at the center of the page. When it comes to layout the balance, equilibrium, stability and sequence are key factors to consider in a good design (Ngo and Byrne, 2001). Bauerly and Liu (2003) as well as Kroemer , Kroemer and Kroemer (2006), evaluated the effect of number of components, grouping, symmetry, and balance on interface aesthetics. Balance refers to whether the content is symmetrical or not, if the vertical length of the content appears to support the same weight of each side. Figure 3.4 shows an example of a possible layout distribution for the experimental Web modules in this study. In this example information appears in three distinct blocks, the video appears in the left superior corner, lesson content index in the inferior left corner and the PowerPoint presentation in the right side occupying both inferior and superior spaces.

Figure 3-4 Example of a possible screen layout design.

Equilibrium should be observed with respect to the centering of page items between them and sequence regarding a logical mental order that people can easily identify while reading of viewing images and graphics (Ngo and Byrne, 2001). A study by the Poynter Institute (2000) showed that users fixate on text not on images until the third or second visit. All of these images are expected to be found in a determined position. For example, advertisements are

expected to be found at half top in a Website. In this manner users have found a way to avoid some part of the Web content modifying their search behavior. Benway and Lang (1998) reported that colorful and obvious banners tend to be ignored by users because people have learned to avoid them. This effect was called “Banner Blindness” is the name given to the tendency to avoid and ignore advertisements (Cho, 2003). The obvious solution or advertisement strategy would be to place relevant content in an unexpected place. A study by Doyle, Minor and Weyrich (1997) proved that banners placed 1/3 down page as opposite to the top generated 77% higher clicking-through rates than banners placed above. In the Web modules designed for this study, banners were placed conveniently at the bottom of the screen leaving sufficient space for video, index and text presentation (PowerPoint presentation). In addition to this technique, a flashing effect was used every time new information was placed in the banner or a new banner appeared. An example of the experimental web module is shown in Figure 3.5. In this image the menu or index is arranged in columns and it is ordered following the course content. As participants view the experimental course, the items listed in the index light up indicating what is being discussed at that determined time. Integration of this type of index also helps participants recap their steps within the lesson.

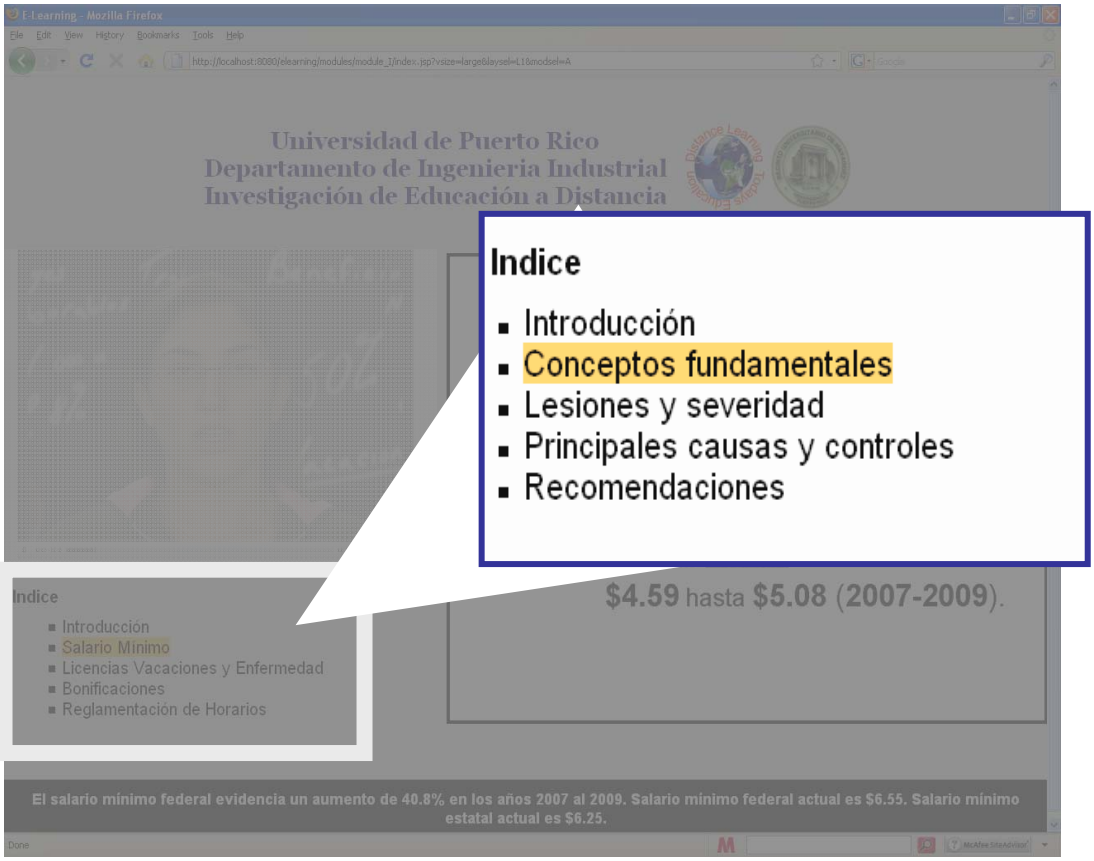

Figure 3-5 Example of lecture interface with large index exposure.

The questionnaire screens that appear at the end of each module have very similar appearance and content. For these screens a refreshing delay time of about 2.2 seconds was used. The longer refreshing times employed at the questionnaire screens help users specially aging individuals notice that it has changed and what has changed. When possible these pages were divided in two sections (Figure 3.6 Sections marked as 1 and 2). In cases, were only a portion of a screen is required to actualize the same delay was imposed. In Figure 3.6 the section tagged as 1 does not change along all similar questions, but in the section tagged as 2, the block that appears in a denser gray color refreshes with an effect that simulates a

window blind, where the contents of the affected elements stay in place when the participant clicks the arrow indicating they have made a selection.

Figure 3-6 Sample of an evaluation screen.

Additionally as eye lenses thicken in the aging adult, there is a reduction in the transmission of blue light. All above may explain why aging users have trouble sorting or matching colors in blue-green and red regions. When designing for aging one of the first recommendations is to have the largest contrast possible in the displayed screen. All experimental instructional

module screens had a Midnight Blue (HEX code#191970) and Black (HEX code #000000) colored fonts over a White Smoke (HEX code #F5F5F5) and Light Gray (HEX code#D3D3D3) background. The Web modules were designed considering five independent variables that were directly applied to the module design, each with two different levels. These variables are (1) Camera Focus, (2) Environment Simulator (Video Background), (3) Video Size, (4) Instructor Gender and (5) Lesson content type. The camera focus corresponds to differences in angle and distance range following standard procedures for News and Talk shows. The modules designed for this study present the instructor video with a (1) face close-up or a (2) half body shot. The face close up includes only the instructor face and neck; while the half body shot shows the instructor form head to approximately the waist line (see Figures 3-7 and 3-8). The environment simulator or video background had two different levels, which include a (1) Classroom simulator or a (2) Studio simulator. The classroom simulator recreated a traditional college classroom, this setup included a blackboard (in some cases containing related notes as if they were written by the instructor), and the instructor's desk and chair (Figure 3.7). The studio simulator resembled the local news delivery and it was filmed over a plain textured background showing the instructor, a chair and desk (Figure 3.8).

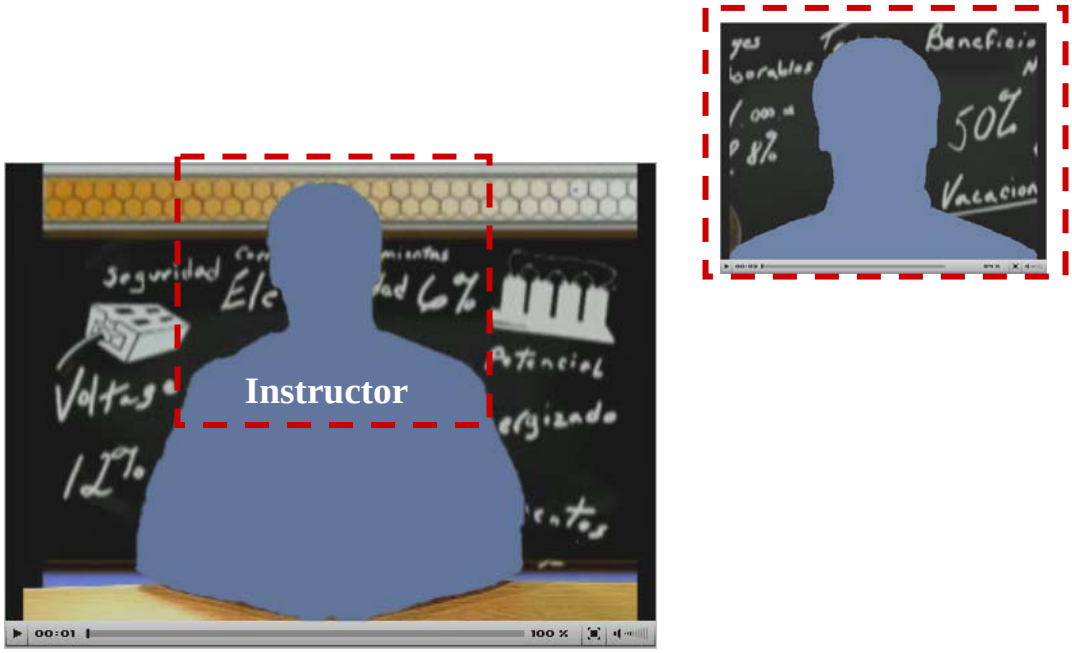

Figure 3-7 Classroom Simulator body (left) and face shot (right).

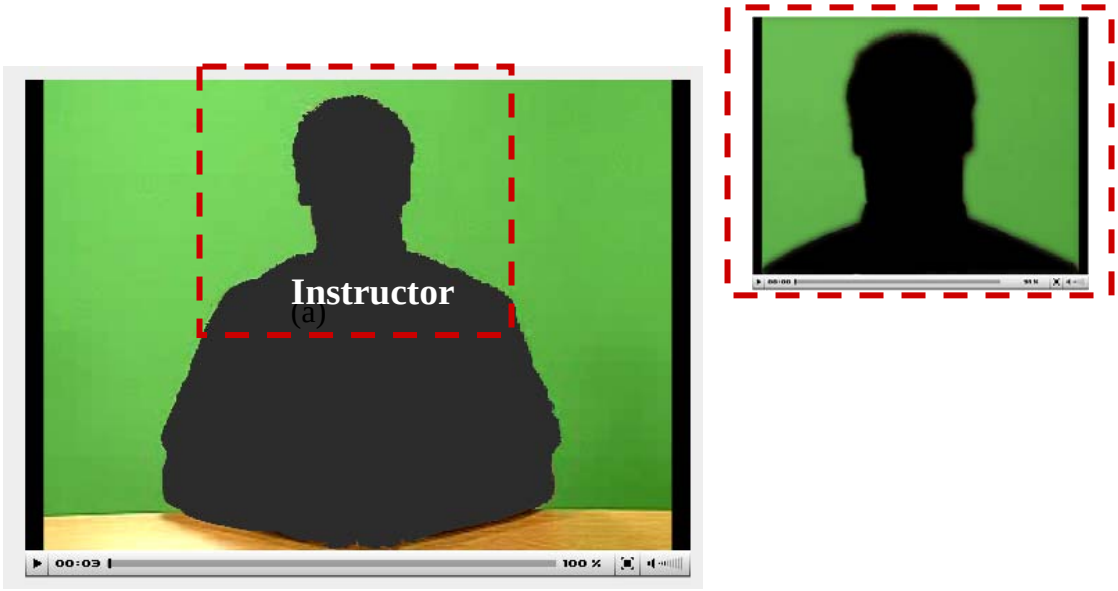

Figure 3-8 Studio Simulator with body (left) and face (right) shot

Video size levels were measured considering the complete screen space. The large video was approximately 480 x 360 pixels and the small video measured approximately 320 x 240 pixels. These sizes were selected purposefully to leave sufficient space for the PowerPoint presentation, the index and the banners. The largest size considers the size used in news broadcasting and entertainment pages in the internet.

The gender variable presented the Web modules either with a female (24 years old) or male (36 years old) instructor. Both instructors presented the two different instructional module lesson types.

The last element present in the experimental Web module screens were the banners. The banners were fixed along all modules therefore it does not represent an experiment factor. Banners are messages that appear sequentially in the inferior part of the page. The main purpose of the banners is to emphasize important content that has been said by the instructor or written in the PowerPoint presentation. These will also serve as assistance messages to aid visual and hearing declining functions for aging. Figure 3.9 demonstrates the interface's blocks (PowerPoint presentation, Index, Banner and instructors' video) for a left upper position layout arrangement selection (LUP)

Figure 3-9 Example of interface design characteristics

Instructional modules presented two different lesson types. The lesson types were either numerical or narrative. One lesson types presented the topic of "Compensations" from de Human Resources area and offered a numerical overview of basic compensation laws any employee should understand such as benefits, retirements, medical plan, minimum wage, vacations, annual rewards and others. All modules with the topic of "Compensations" are considered in this study as numerical lesson type.

The Electrical Safety topic, from the Health and Safety area, is narrative rather than numerical and computational. The differences in lesson types may offer insight of the effects of text processing versus number processing with the same interface characteristics. Independent on the lesson type and design variables, each module had a length period of approximately 6 to 8 minutes.

3.4 Video Design Criteria

In this study a great deal of attention is paid to the details of video production. It is believed that it is not enough to film an instructor lecturing as he/she would in a regular traditional classroom; camera placements, camera movements, as well as image quality was closely observed. Video filming and editing was carried out at a local channel “WORA tv” Telecinco, Inc. affiliated to UNIVISION. All videos were recorded in a single customized studio for picture editing. This studio was fully covered in a pure green fabric. The two techniques used to generate the video background were “croma” and “green style”. Halogen lamps were used for the recording. These were: a key light of 1,000 watts, a fill light of 1,000 watts, a back light of 1,000 watts and two (2) background lights of 1,000 watts. 219 footcandles was the illumination level over the instructor. Additionally, a professional television camera was used in the filming (Grass Valley HD DPM LK-6000 with a FUJINON 18 x 7.6 lens). Lens aperture was 2.8 at 7 feet of distance from the lens. A professional teleprompter enabled the remaining video filming conditions. Each video recording was approximately 6 to 8 minutes long. Editing was done in a personalized software package created for this local television

channel. Through this editing software backgrounds were created virtually to comply with the proposed experimental conditions.

3.5 Experimental Procedure and Testing

Participant recruitment was done through flyers and email invitations. After accepting an invitation to participate in the study, each participant received a personal code to complete an online questionnaire to collect information concerning demographic data and learning styles (See appendix A). This first step occurred remotely before the experiment started. Then each participant received preliminary instructions, participated in the informed consent process and received a short preview of what they were about to view, what to expect, and what physical activities were required such as clicking and dragging. Participants were then given 2 minutes to ask questions regarding procedure and to accommodate the station (chair, speaker or headphones volume) before starting the experiment.

All participants viewed four (4) out of the sixteen (16) modules according to the experimental designs developed. They also completed five (5) different tasks before and after viewing each module. Each participant passively viewed the Web modules observing the content displayed in the desktop computer after selecting the layout arrangement of their preference for the course they were about to see. Participant's interaction was recorded utilizing a Webcam to capture the physical interaction part and the Morae usability software

recorded the virtual part of the interaction. This is, activity displayed on screen such as selecting, pointing, clicking and dragging.

After viewing the experimental instruction modules, each participant was requested to write exclusively all words they remembered for the narrative modules or all numbers for the numerical modules, they had two minutes for this activity. Answers to this question were the input used to measure information recall which addresses shot term memory. When the two minutes had passed, the continue option would enable in the computer screen notifying participants they should continue the evaluation.

After the information recall question, each participant answered three short questionnaires that measure Satisfaction (Cook 1991), Disorientation (Beasley and Waugh 1995) and Task Workload (Hart and Staveland 1988). The study participants had no time limit to answer the short questionnaires. All questions were presented without advising the participant the particular instrument they belonged to. Questions were ordered by numbers and the sequence continued along all three questionnaires. Participants were instructed to complete the questions by the following instructions: (Questions regarding each instrument can be found in appendix B, C and D respectively)

1. In each of the statements below, the scales corresponds to something that a person might say about taking an online course. Please indicate your own personal feelings about your experience by selecting the number that expresses how much you agree with each of the statements.
2. Please select the response that best indicates your feelings.
3. (a) Select by clicking the dot under the number on each scale that represents the magnitude of each factor in the task you just performed. (b) On each of the following screens click on the scale title that represents the most important contributor workload for the task.

After the completion of the questionnaires the process started again with each participant viewing the initial screen for layout selection. At this time each participant had the opportunity to select a different or similar layout before they could view a different module and answer the questionnaires for each one. This process was repeated four (4) times to complete the (4) modules each participant had to evaluate. After viewing the four modules a valuation activity occurred. For the valuation activity an additional page that contained a question and a comment section was provided for participants who desired to describe their experience, offer recommendations for improvement or write their thoughts about the task they had just performed. This page was made available in hard copy and it was placed in their work space at the beginning of the task. If participants in fact decided to offer

comments, unlimited time was offered after they had viewed and evaluated all four (4) modules. After participants completed this last step no follow up activities were required.

Figure 3.10 summarizes testing activities and experimental procedure. The activities shown in the figure represent only those activities concerning the experimental procedure. These activities do not show the instructional module coding and usability testing runs as well as validation of all contents and procedures through the Committee for the Protection of Human beings in Research (CPSHI) and other preparation and planning activities (Appendix H).

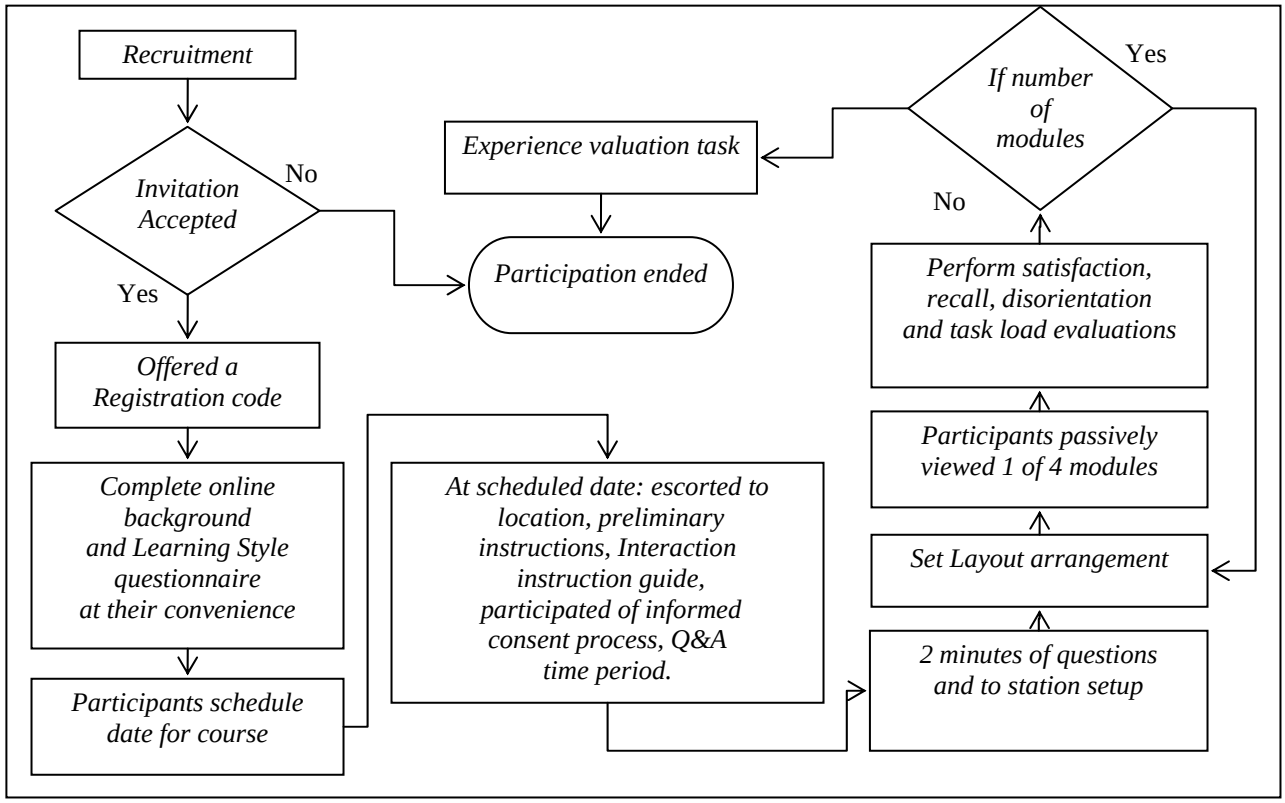

Figure 3-10 Experimental Procedure and Testing Flowchart

3.6 Experiment Design Analysis

To determine an appropriate experiment design this study considers the following limitations:

-Each subject must view no more than 4 modules.

-Experimentation process must be no longer than one hour without a break period.

-Experimentation procedure must be completely executed on a single day.

-All modules should be viewed the same number of times.

-Each participant viewed each module just once

The resultant design was a fractional factorial design 2^{4-1} with resolution IV. This design was replicated in two different lesson content types (narrative and numerical) each of these applied to two sample sets (young 25 to 35 and aging 55 to 65). This fraction depicted a total of 8 treatments for each lesson content type.

3.6.1 Independent variables

As described in section 3.3, these are camera focus, environment simulator, video size and instructor's gender. These are included in each module or treatment as exposed in Table 3.1 for more clarity.

Table 3-1Treatment Description by Module Design Variables

Modules/ Treatments	Module Design Variables							
	Camera focus		Environment Simulator (Background or No-Background)		Instructor's Gender		Video Size	
	Face	Body	NB	B	F	M	Small	Large
Module A	x			X	x		x	
Module B	x			X		x		x
Module C	x		x			x	x	
Module D	x		x		x			x
Module E		x		X		x	x	
Module F		x		X	x			x
Module G		x	x		x		x	
Module H		x	x			x		x
Module I	x			X	x		x	
Module J	x			X		x		x
Module K	x		x			x	x	
Module L	x		x		x			x
Module M		x		X		x	x	
Module N		x		X	x			x
Module O		x	x		x		x	
Module P		x	x			x		x

To assign participants to each treatment order, the number of repetitions had to be assured. These tables (Tables 3.2 and 3.3) show the sixteen treatments which correspond to the modules labeled with letters, where modules A to H represent the narrative content type modules and modules I to P are the numerical content type modules. Each participant viewed four modules. Each individual module was viewed only once by each participant, all in a different exposure order. Take for example the number selected under the red circle.

This number corresponds to subject number two, who was determined following the order of acceptance of invitations to participate in the study. This subject viewed modules: “A” in first place, followed by module “H” in second place, module “G” in third place and lastly module “B”.

Table 3-2 Experiment Matrix Used to Assign Participants to Treatment Modules A-H

Order	Module A	Module B	Module C	Module D	Module E	Module F	Module G	Module H
1	2, 34	6, 38	1, 33	5, 37	9, 41	13, 45	10, 42	14, 46
	4, 36	8, 40	3, 35	7, 39	11, 43	15, 47	12, 44	16, 48
2	6, 38	10, 42	5, 37	9, 41	13, 45	1, 33	14, 46	2, 34
	8, 40	12, 44	7, 39	11, 43	15, 47	3, 35	16, 48	4, 36
3	10, 42	14, 46	9, 41	13, 45	1, 33	5, 37	2, 34	6, 38
	12, 44	16, 48	11, 43	15, 47	3, 35	7, 39	4, 36	8, 40
4	14, 46	2, 34	13, 45	1, 33	5, 37	9, 41	6, 38	10, 42
	16, 48	4, 36	15, 47	3, 35	7, 39	11, 43	8, 40	12, 44

Table 3-3 Experiment Matrix Used to Assign Participants to Treatment Modules I-P

Order	Module I	Module J	Module K	Module L	Module M	Module N	Module O	Module P
1	18, 50	22, 54	17, 49	21, 53	25, 57	29, 61	30, 62	30, 62
	20, 52	24, 56	19, 51	23, 55	27, 59	31, 63	28, 60	32, 64
2	22, 54	26, 58	21, 53	25, 57	29, 61	17, 49	30, 62	18, 50
	24, 56	28, 60	23, 55	27, 59	31, 63	19, 51	32, 64	20, 52
3	26, 58	30, 62	25, 57	29, 61	17, 49	21, 53	18, 50	22, 54
	28, 60	32, 64	27, 59	31, 63	19, 51	23, 55	20, 52	24, 56
4	30, 62	18, 50	29, 61	17, 49	21, 53	25, 57	22, 54	26, 58
	32, 64	20, 52	31, 63	19, 51	23, 55	27, 59	24, 56	28, 60

3.6.2 Dependent variables

As briefly discussed in section 1.3.5 dependent variables are information recall, satisfaction, disorientation and task workload. Information recall can be used as a measure of user attention to the current task (Pomales and Liu, 2006); satisfaction has been used to measure feelings such as boredom, mental effort, independent thought and challenge (Cook, 1991); disorientation can be used as a measure of user awareness, confusion, easiness, comfort, organization and mental structure of the lesson content, and uncertainty (Beasley and Waugh, 1995); task workload provides insights into requirement of resources to perform tasks endings in temporal demands, mental and physical demands, effort, frustration and performance (Hart and Staveland, 1988).

Information recall was measured through an open question that stated: “Please write below within the next two minutes all the words you can remember from lesson content”. User satisfaction, disorientation and task workload were also measured and analyzed using three separate questionnaires (Appendix A, B, C and D).

The data obtained with the instruments to collect dependent measures was entered in Minitab software in response columns. Data was analyzed with Minitab factorial analyzing tools. The level of significance used in the resultant model was 0.05 where the null hypothesis is rejected when the level of significance is lower than the level of significance. Table 3-4 provides the list of abbreviations for the results depicted from data analysis.

Table 3-4 List of Abbreviations for the Experiment Design Analysis

DF	Degrees of Freedom	**Seq SS**	Sequential Sum of Squares
Effect	Estimated Effect	**Adj SS**	Adjusted Sum of Squares
Coef	Sources Coefficient for Regression Equation	**SE Coef**	Standard Error Coefficient
P	P-Value	**R-Sq**	R-Square
T	T –Value	**R-Sq(adj)**	Adjusted R-Square

Given that the validity of the ANOVA results depend on a series of assumptions (compliance with homogeneity of the variance, independence and normal distribution of the residuals) Normal Probability Plot, Standardized Residuals vs. Fitted Values and Standardized Residuals vs. Order plots are included in the appendix section (Appendix F) all proving satisfactory results.

4 Results

4.1 Information Recall

Table 4.1 displays the significant terms for the information recall response. Where lesson content type, environment simulator, video size, age and two two-way interactions of age and environment simulator and size and age present p-values < 0.05.

Table 4-1 Estimated Effects and Coefficients for Recall (coded units)

Term	Effect	Coef	SE Coef	T	P
Constant		16.3945	0.3740	43.84	0.000
Content Type	3.555	1.777	0.3705	4.80	0.000
Environment	-2.789	-1.395	0.3705	-3.76	0.000
Size	-5.805	-2.902	0.3705	-7.83	0.000
Age	-7.977	-3.988	0.3705	-10.76	0.000
Environment*Age	1.758	0.879	0.3705	2.37	0.020
Size*Age	3.523	1.762	0.3705	4.75	0.000

S = 5.98386 R-Sq = 48.89% R-Sq(adj) = 47.65%

Where the regression equation is:

Recall = 16.4 + 1.78 Content Type - 1.39 Environment - 2.90 Size - 3.99 Age + 0.879 Environment*Age + 1.76 Size*Age.

For the main effects (as shown in Table 4.2) the information recall response is approximately 4 words more when modules present a narrative information content instead of a numerical content, approximately 3 words when the environment simulator has no background or has a plain textured background, about 6 words more when video size is large. Significant two-way interactions show that young participants (25 to 35 years) recalled about 2 words more when the simulated environment displayed in the video had no background and nearly 4 words more if video was large.

Table 4-2 Regression Equation Predictors and Coefficients for Recall

Recall =	16.39	
Content type	1.77	If lesson content type is narrative
	-1.77	If lesson content type is numeric
Environment	1.39	If video environment does not have background
	-1.39	If video environment has background
Size	2.90	If video is large
	-2.90	If video is small
Age	3.988	If age is 25 to 35 (young group)
	-3.988	If age is 55 to 65 (aging group)
Environment*Age	0.879	If video environment does not have any background and age is 25 to 35 years
	-0.879	If video environment has background and age is 55 to 65 years
Size*Age	1.762	If video is large and age is 25 to 35 years
	-1.762	If video is small and age is 55 to 65 years

As presented in Figure 4.1 main effects occurs when the mean response changes across the levels of a factor. Notice that comparing the response effects across factors, information recall increases when the lesson type is narrative, there is no background (studio simulator background), the video display is large and with the younger sample set. In the case of the age factor, higher levels of information recall were expected due to the declining memory functions that occur with aging.

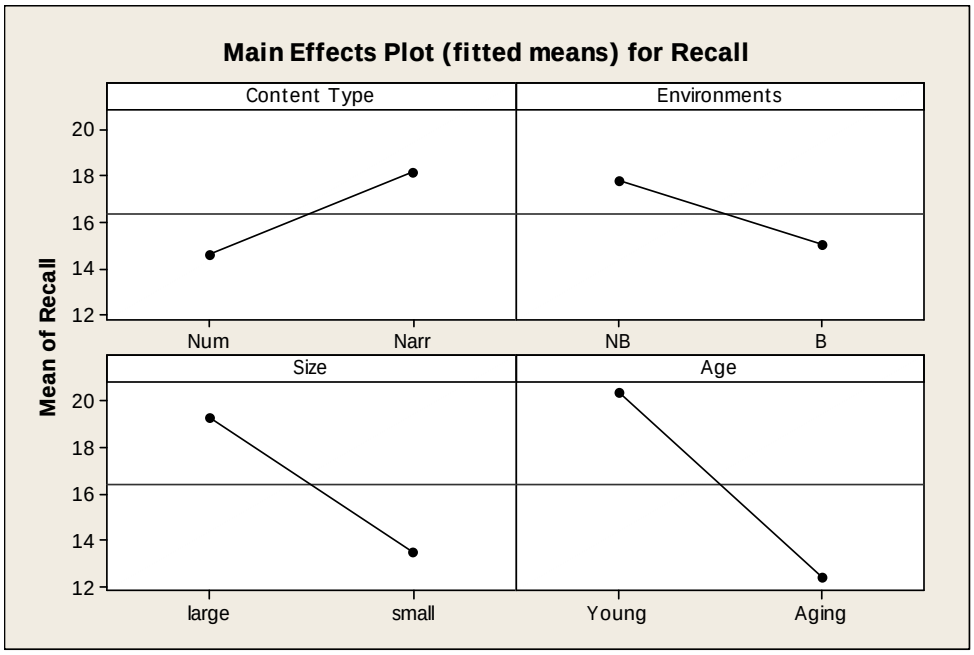

Figure 4-1 Main Effects Plot for Information Recall

4.2 Satisfaction

Satisfaction response proved significant main effects. These are Age and lesson content type.

Table 4.3 displays the estimated effects and coefficients for the satisfaction variable.

Table 4-3 Estimated Effects and Coefficients for Satisfaction (coded units)

Term	Effect	Coef	SE Coef	T	P
Constant		3.68197	0.04592	80.18	0.000
Content type	0.1816	0.0908	0.04592	1.98	0.049
Age	0.7415	0.3708	0.04592	8.07	0.000

S = 0.734723 R-Sq = 21.45% R-Sq(adj) = 20.83%

Where the regression equation is:

Satisfaction = 3.68 + 0.0908 Environment + 0.371 Age

This is, as shown in Table 4.4, perceived satisfaction is higher in narrative content modules and in the aging group. The response for satisfaction used a scale of 1 to 7 were the number 7 represents maximum satisfaction expressed in terms of producing certain feelings challenge, independent thought, and low levels of mental effort and sense of boredom.

Table 4-4 Regression Equation Predictors and Coefficients for Satisfaction

Satisfaction =	3.68197	
Content type	0.0908	If lesson content type is narrative
	-0.0908	If lesson content type is numeric
Age	0.3708	If age is 55 to 65 (young group)
	-0.3708	If age is 25 to 35 (aging group)

The results in Figure 4.2 show that module and age have significant changes between levels. By comparing the response effects across factors, the plots show that satisfaction increases when lesson content type is narrative and satisfaction was significantly higher for older individuals than for younger individuals. Differences in the level of satisfaction may be triggered by the novelty or challenge associated with a novel task. The aging group was the most inexperienced group concerning computer knowledge and online courses.

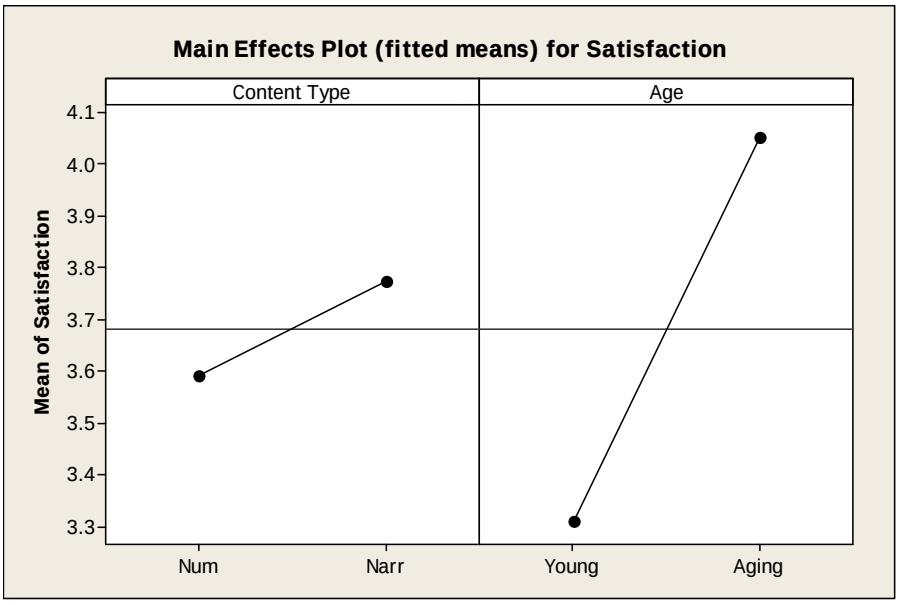

Figure 4-2 Main effects Plot for Satisfaction

4.3 Disorientation

Table 4.5 displays the significant terms for Disorientation. In this case Age and a two-way interaction of age and content type present p-values under 0.05.

Table 4-5 Estimated Effects and Coefficients for Disorientation (coded units)

Term	Effect	Coef	SE Coef	T	P
Constant		29.4063	0.1935	151.96	0.000
Age	1.0937	0.5469	0.1935	2.83	0.005
Content Type*Age	1.0625	0.5313	0.1935	2.75	0.006

S = 3.09630 R-Sq = 5.84% R-Sq (adj) = 4.72%

Where the regression equation is:

Disorientation = 29.4 + 0.547 Age + 0.531 Content Type*Age

The level of disorientation was measured in a scale from 10 to 50, where 10 indicates that the designed interface does not produce disorientation in the individual and 50 is the highest value, indicating the individual is completely disoriented. For the model shown in Table 4.6, disorientation will be approximately 1 point higher for aging individuals, 55 to 65 years. In addition, aging individuals will be more disoriented by 1 point with narrative content type modules compared to young individuals. Numerical content type modules will depict a lower level of disorientation in aging individuals by 1 point than when compared with young individuals.

Table 4-6 Regression Equation Predictors and Coefficients for Disorientation

Disorientation =	29.4063	
Age	0.5469	If age is 55 to 65 (young group)
	-0.5469	If age is 25 to 35 (aging group)
Content Type*Age	0.5313	If lesson content type is narrative and Age is 55 to 65 years
	-05313	If lesson content type is numeric and Age is 25 to 35 years

The Figure 4.3 displays the main effects for disorientation. This plot shows that disorientation is higher in aging individuals compared to young individuals. This is, related to the aging individuals, feelings of confusion, easiness, comfort, organization and mental structure of the lesson content and uncertainty possibly caused by the same inexperience of in computer knowledge of the experimental subjects or participants.

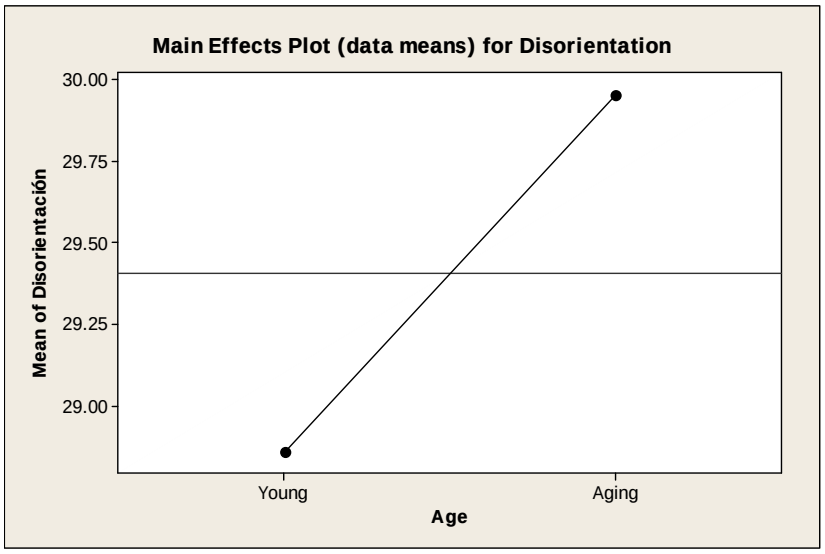

Figure 4-3 Main Effects Plot for Disorientation

4.4 Task Load

Task Load proved a main effect (Age) and a two-way interaction between module content type and Age to be significant sources as shown in table 4.7.

Table 4-7 Estimated Effects and Coefficients for Task Load (coded units)

Term	Effect	Coef	SE Coef	T	P
Constant		45.520	0.9788	46.51	0.000
Age	-12.773	-6.387	0.9788	-6.53	0.000
Content Type*Age	8.268	4.134	0.9788	4.22	0.000

S = 15.6604 R-Sq = 19.99% R-Sq(adj) = 19.04%

Where the regression equation is:

Task Load = 45.5 - 6.39 Age + 4.13 Content Type*Age

This is, as presented in Table 4.8, the level of task workload which was measured between 1 and 100 is lower by 12 points in aging individuals compared to young individuals. In addition, workload is approximately 8 points higher in young individuals viewing numerical modules.

Table 4-8 Regression Equation Predictors and Coefficients for Task Load

Task Load =	45.520	
Age	6.387	If age is 25 to 35 (aging group)
	-6.387	If age is 55 to 65 (young group)
Content Type*Age	4.134	If lesson content type is narrative and Age is 55 to 65 years
	-4.134	If lesson content type is numeric and Age is 25to 35 years

The Figure 4.4 displays the main effects for task load. The mean response changes drastically across the levels of the Age factor implying higher levels of workload in young individuals compared with the older individuals. This suggests that young individuals required more cognitive and physical resources to perform this task. One possibility is that the design interface considered important and specific limitations for the older population making the design perhaps less appealing to the younger age group and more difficult to stay engaged in the study's experimental tasks.

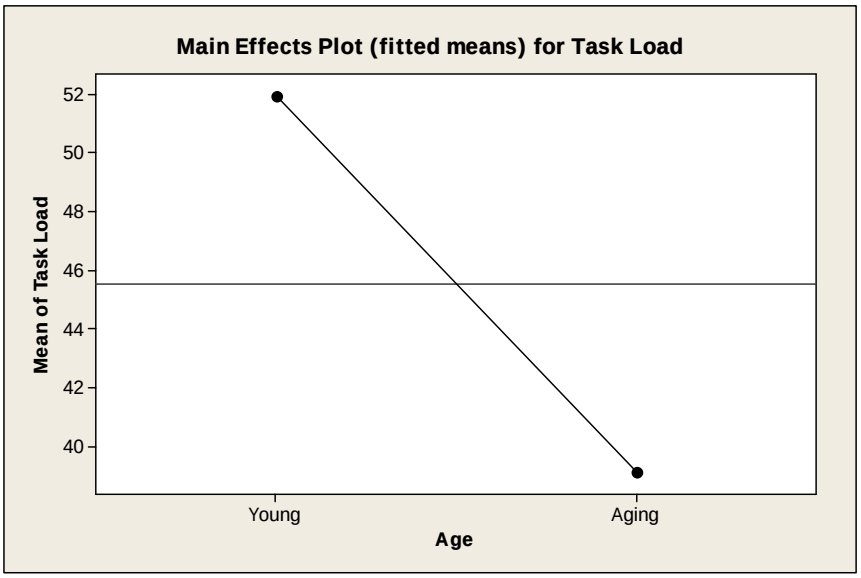

Figure 4-4 Main Effects Plot for Task Load

4.5 Filming Techniques

How do filming techniques employed in professional television production (Camera Focus, Background Simulators and Size) affect the user response (Information Recall, Satisfaction, Disorientation and Task Workload) when adapted to the video in the learning interface?

The filming techniques employed in the creation of the course or training video only had a significant impact in the retention (information recall) variable measured addressing short term memory. The environment simulator factor (classroom simulator background and studio simulator background) and the video size (small and large) affected the response.

Indicating an increase in the information recalled when the video display presents a studio simulator or a plain color background (No-Background) and the video display is in its larger size.

4.6 Interface Information Sources and Information Recall

What information does the individual memorize whether it is what is narrated by the instructor, the banner content or the PowerPoint presentation content?

The experiment design proved that the lesson content type, Environment Simulator, Size and Age factors play a significant role in the information recall response. To answer the above stated question it is necessary to recur to the sources that provide information within the course interface. In all displayed modules there were three sources of information flow in addition to the table of content or index (for which even though displayed information did not change, all items were highlighted to guide participant through the course progression). The different sources of information stimulated two different information process channels, the auditory and the visual. These were the instructor's voice (auditory) from the video, and the PowerPoint presentation and the banners (visual). All sources of information streamed the same type of content. In this way, PowerPoint presentation as well as banners provided complementary information to the content exposed by the instructor in the course video. Each of the sources used different words to enable locating recalled words with a specific source.

It is important to remember that this task did not intend to measure application or learning of content, the purpose was to measure attention associated with the information recalled within two minutes after participants had viewed content. To demonstrate how the different information sources impacted information recall, lets consider one example. In Module E, information displayed in the banner read: *"Causa el 12% de las muertes de los trabajadores jóvenes. Aproximadamente 450 de las muertes son causadas por electrocución"*. The PowerPoint presentation displayed the title: *"Heridas y quemaduras por choque eléctrico"* and the instructor said*: -"Utilice protección personal: zapatos de seguridad apropiados no tenis o chancletas. Utilice guantes apropiados con goma, mangas y mantas". "...Utilizar cables fijos mejor que cables flexibles". "...por ejemplo: la utilización de: las guardas, cajas y aperturas"*.- A voluntary participant registered as User_11 recalled: *"no tenis ni chancletas, cables fijos cajas guardas, aperturas, trabajadores jóvenes, planifique, quemaduras choques eléctricos, muertes"*. Observe how participant recalled the simple underlined words from what was verbally expressed by instructor. Also, the two words with the double underlining can be located within the banner content and finally words without the underline effect can be identified within the PowerPoint content. In this example the participant recalled 3 words from the banner, 3 words from the PowerPoint presentation and 7 words from the video, for a total of 8 words recalled. In general the narrative content type modules with small video display had a higher average value of recalled words from what was orally expressed by the instructor in both young and aging participants. Banners reached similarly high values compared to the PowerPoint presentation content recall for the younger participants.

PowerPoint presentation did not have a significant contribution in the information recalled. Aging participants responded differently recalling more information from the PowerPoint presentation with respect to the banners, although they seem to have very similar values (see Figure 4.5 a). For notation clarity lesson content type has been divided with letters. Modules labeled A to H are narrative modules and modules labeled with letters I to P are modules with a numerical or computational content. For the numerical module type with small video display (Figure 4.5 b), the amount of information recalled of the three information sources in the course interface was different compared to the narrative lessons. PowerPoint presentation and what was orally expressed by the instructor shows a nearly indistinguishable line implying that the average of information recalled were merely the same for these two sources. This result applies to both age sets studied. In either sample sets or age groups, the information recalled from the banners was very low. Observing Figure 4.5 (b), it is interesting to notice that as aging individuals recall none or just few words from the banners in the numerical modules and young individuals slightly remember words and recall shortly its content.

Figures 4.5 (c) and 4.5 (d) show the average values of the recalled words for the two groups of participants for modules that have a large size video. These below displayed figures suggest results similar to the results for the modules or lessons with small video. The amount of recalled words from each source is similar when comparing each type of lesson with the different video sizes (narrative module with small video display and narrative module type

with large video display and numerical module with small video display and numerical module content type with large video display). This may imply that the video size is not related to the selection of information (provided by the different sources) the individual is able to recall.

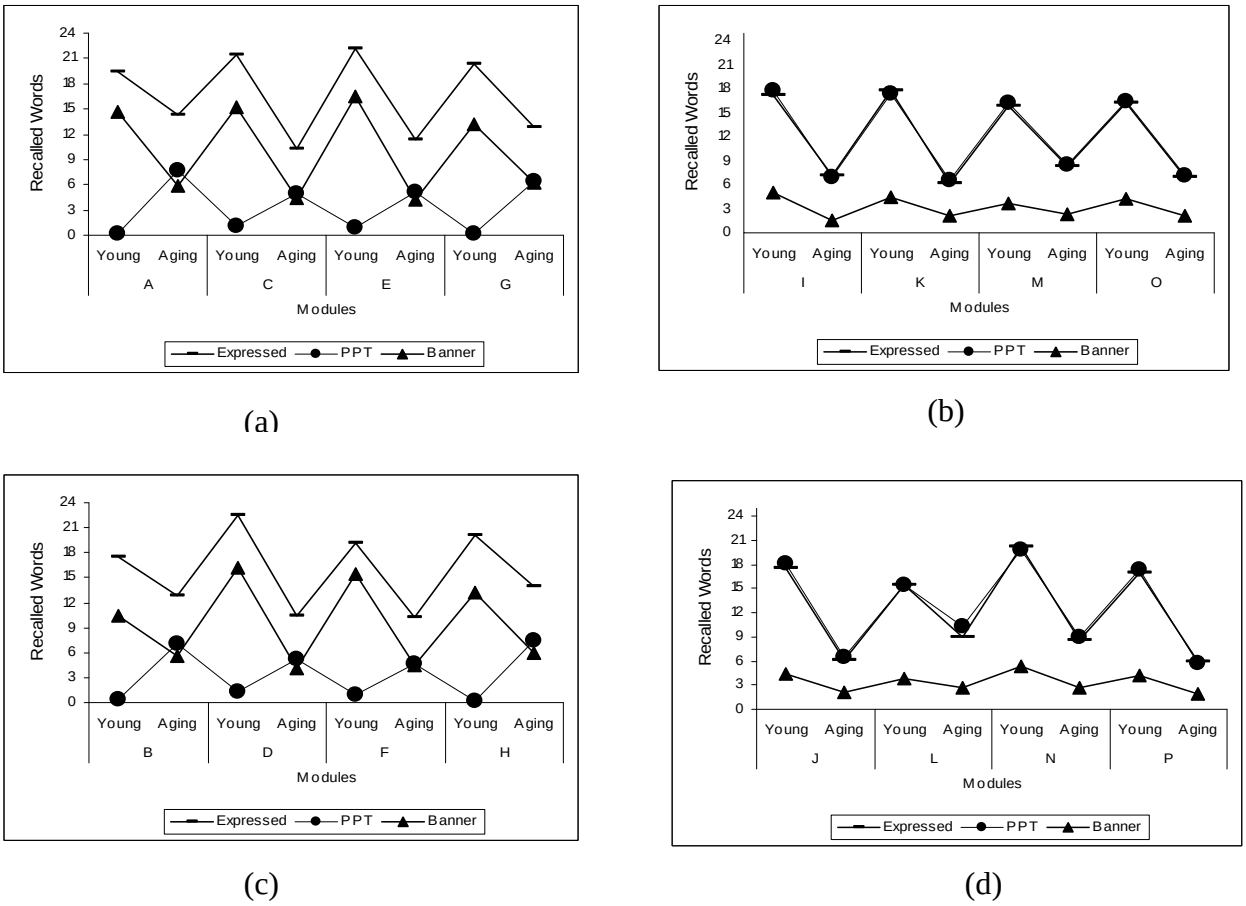

Figure 4-5 Information Recall by Sources for: (a) Narrative Modules with Small Video, (b) Numerical Modules with a Small Video, (c) Narrative Modules with Large Video, and (d) Numerical Modules with Large Video

Figure 4.6 (a), (b), (c) and (d) show that narrative content type lessons had a higher average value of recalled words from what was orally expressed by the instructor for both young and aging participants. Young participants were able to recall more information from the banners but just few words from the PowerPoint presentation. Aging participants on the other hand, recalled similar amounts of words for both the PowerPoint presentation and banners. For the numerical lesson or module type the PowerPoint presentation and what was orally expressed by the instructor are represented by two almost equal lines implying that the average values of information recalled were approximately the same for these two sources. Banner recall was relatively low for both sets of participants. In both, narrative and numerical modules with simulated classroom background and plain background videos, the results revealed the same conclusions obtained with the different video sizes. Small video display and the simulated classroom video background as well as modules that contain videos with plain background exhibit equal results when compared with the large video displays. This may strongly suggest as stated before that the video size and the environment simulator (Backgrounds) are not related to the selection of information (provided by the different sources) the individual is able to recall.

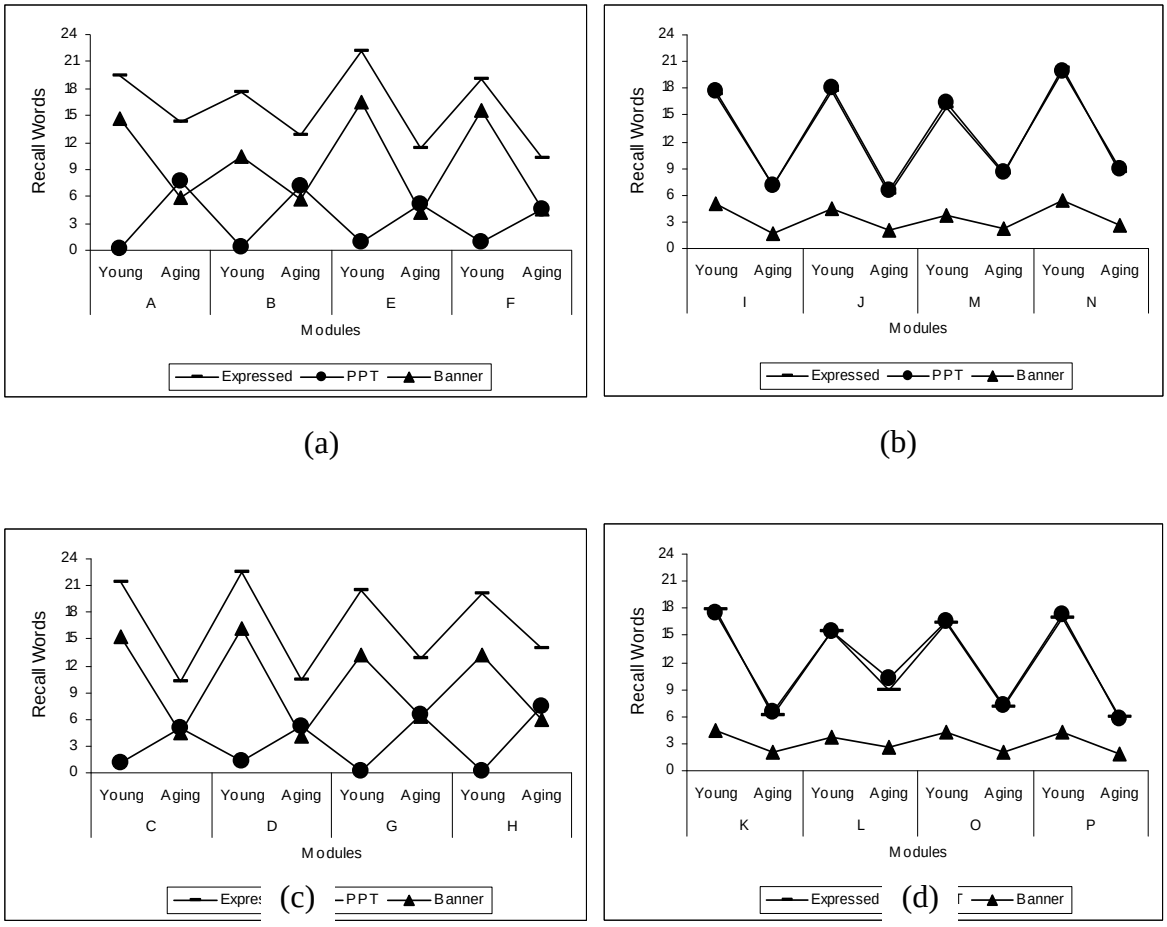

Figure 4-6 Information Recall by Sources for: (a) Narrative Modules with background, (b) Numerical Modules with background, (c) Narrative Modules with no background, and (d) Numerical Modules with no background

Age was the last mentioned factor to prove to be significant in the information recalled by participants. Figures 4.5 and 4.6 displayed at this section show a clear difference between the amounts of information recalled by both age groups. This is easily identified by the ups and downs in each information source (Expressed, PowerPoint, and Banner). Young individuals

recalled more information from almost all sources with the exception of the banners in the narrative cases. Nonetheless, although aging individuals recalled less words from the modules overall content, they managed to retain information from all sources, this not being the case of young individuals who in some cases recalled just a few or no word from the banners. These interesting findings lead to an additional analysis to identify the resource allocation strategy of each group. To understand the resource allocation strategy of each group there are two main assumptions:

- *the video size and the environment simulation background are not related to information (provided by the different sources) that an individual is able to recall,*
- *the auditory stimulus provided by the video is constant and does not compete with the banner and the power point information*

To answer this question the initial experiment design now collapses into a 2^2 factorial design were dependent variables are the percentage of words recalled by each source considering the total amount of words each individual remembered from the different information sources. This is, information recalled from banners and information recalled from PowerPoint presentation. Independent variables in this case are the lesson content type and Age. Dependent measures were introduced in Minitab software in response columns. Data was analyzed with Minitab factorial analyzing tools. The level of significance used in the

resultant model was 0.05 where the null hypothesis is rejected when the level of significance is lower than the level of significance.

4.6.1 Banner Information Recall

Table 4.9 displays the significant terms for the banner information recall. Where lesson content type, Age, and the two-way interaction of these factors present p-values under 0.05.

Table 4-9 Estimated Effects and Coefficients for Banner Recall (coded units)

Term	Effect	Coef	SE Coef	T	P
Constant		21.166	0.3733	56.70	0.000
Age	-9.284	-4.642	0.3733	-12.43	0.000
Content Type	19.688	9.844	0.3733	26.37	0.000
Age*Content Type	-9.679	-4.840	0.3733	-12.96	0.000

S = 5.97322 R-Sq = 80.16% R-Sq(adj) = 79.92%

Where the regression equation is:

Banner Recall = 21.2 - 4.64 Age + 9.84 Content Type - 4.84 Age*Content Type

This is, as shown in Table 4.10 that the information recalled from banners is approximately 9.3% higher in young individuals compared to aging individuals. Also, banner information recall is about 20% higher in narrative content type modules. The memorized information of banners is about 10% higher for numeric content and young individuals.

Table 4-10 Regression equation predictors and coefficients for Banner Recall

Banner Recall =	21.166	
Age	4.642	If age is 25 to 35 (young group)
	-4.642	If age is 55 to 65 (aging group)
Content type	9.844	If lesson content type is narrative
	-9.844	If lesson content type is numeric
Content Type*Age	4.840	If lesson content type is numeric and age is 25 to 35
	-4.840	If lesson content type is narrative and age is 55 to 65

Figure 4.7 displays the main effects for the information recalled from the banner's content.

The mean response changes drastically across the levels of the Age factor and lesson content type. Implying higher levels of recall in young individuals and narrative lesson content type compared with the older individuals and the numerical content.

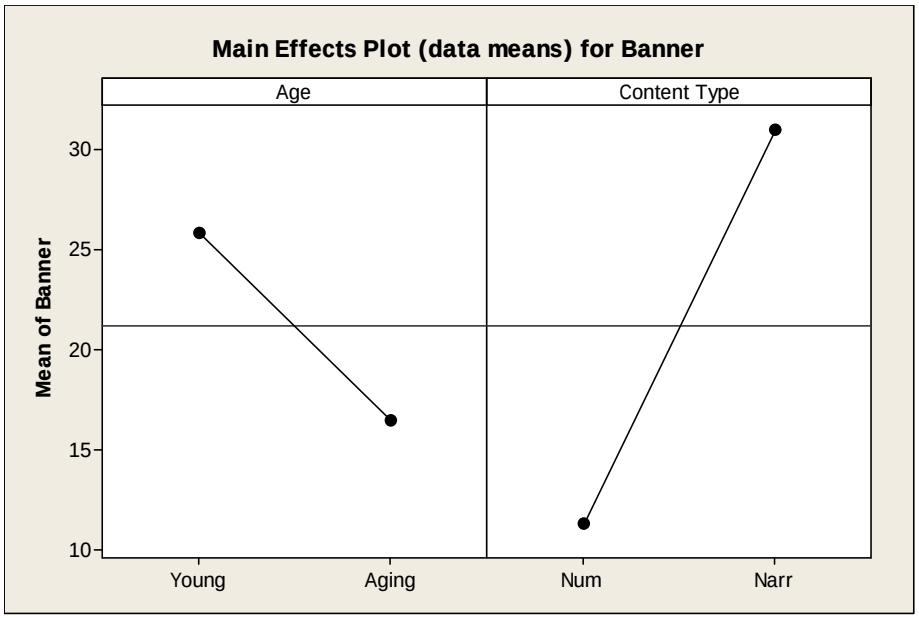

Figure 4-7 Main effects plot for banner information recall

4.6.2 PowerPoint Information Recall

Table 4.11 displays the significant terms for the PowerPoint presentation information recall. Where lesson content type, Age, and the two-way interaction of these factors present p-values under 0.05.

Table 4-11 Estimated Effects and Coefficients for Banner Recall (coded units)

Term	Effect	Coef	SE Coef	T	P
Constant		28.99	0.3591	80.72	0.000
Age	11.50	5.75	0.3591	16.02	0.000
Content Type	-30.59	-15.30	0.3591	-42.60	0.000
Age*Content Type	12.13	6.06	0.3591	16.89	0.000

S = 5.74505 R-Sq = 90.34% R-Sq(adj) = 90.22%

Where the regression equation is:

PowerPoint Recall (PPT) = 29.0 + 5.75 Age - 15.3 Content Type + 6.06 Age*Content Type

This is, as shown in Table 4.12 that the information recalled from the displayed PowerPoint presentation is approximately 12% higher in aging individuals compared to young individuals. Also, PowerPoint information recall is about 31% higher in numeric content type modules. In addition, the memorized information from this source is about 12% higher when the module displayed has a narrative content for young individuals.

Table 4-12 Regression Equation Predictors and Coefficients for PPT Recall

PPT Recall =	28.99	
Age	5.75	If age is 55 to 65 (aging group)
	-5.75	If age is 25 to 35 (young group)
Content type	15.30	If module is numeric
	-15.30	If module is narrative
Content Type*Age	6.06	If module is narrative and age is 55 to 65
	-6.06	If module is numeric and age is 25 to 35

The Figure 4.8 displays the main effects for the information recalled from the PowerPoint presentation. This plot shows that disorientation is higher in aging individuals compared to young individuals. This is, related to the aging individuals, feelings of confusion, easiness, comfort, organization and mental structure of the lesson content and uncertainty possibly caused by the same inexperience of in computer knowledge of the experimental subjects or participants.

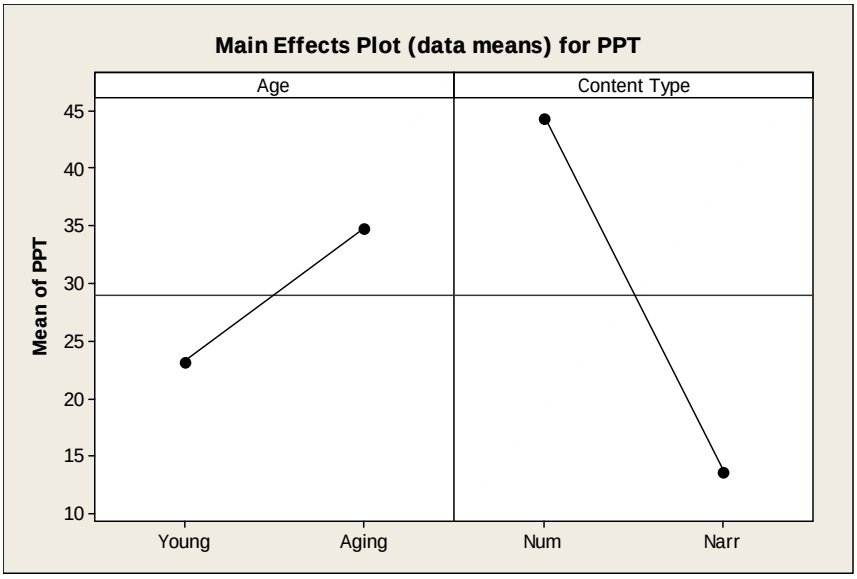

Figure 4-8 Main effects plot for banner information recall

4.7 Instructor's Gender

How are experimental variables (Information Recall, Satisfaction, Disorientation and Task Load) affected by the instructors' gender?

Instructors' gender did not prove through the designed experiment to be significant in the information recall attained by participants or the level of satisfaction produced by each module nor did it have any effect in the levels of disorientation or task load. Instead instructor's gender was identified as a matter of preference for each group. This is exposed with more detail in the experience valuation section 4.9.

4.8 Layout Arrangement

How layout arrangement preferences change based on lesson content (numerical compared to narrative information)?

As previously mentioned in sections 3.3 and 3.5 subjects were allowed to arrange the layout composing each module before viewing its content. To perform this task participant's dragged the icon that represented one of the elements composing the course interface and placed it at the location of their preference within the simulated screen image (Figure 3.3). For analysis interpretation purposes Figure 4.9 displays the position labels. In terms of design each position label represents a different configuration and layout setting.

LUP	**RUP**
LLP	**RLP**

Figure 4-9 Possible Video Layout Locations (LUP=left upper position, RUP= right upper position, LLP=left lower position, RLP=right lower position)

This task was meant to identify any significant difference between and within age and gender. To determine the association between variables in the collected data a Chi Square Test was performed. In all below cases the independence hypothesis will be:

Null Hypothesis (Ho): There is no association between variables A (gender or module type) and B (Layout arrangement).

Alternative Hypothesis (Ha): There is association between variables A (gender or module type) and B (Layout arrangement).

Homogeneity hypothesis are:

Null Hypothesis (Ho): Proportions for each value of the variable B (Layout arrangement) are the same in each column.

Alternative Hypothesis (Ha): At least one of all proportions for each value of the variable B is not the same in each column.

4.8.1 Layout analysis for young individuals (25 to 35 years old)

4.8.1.1 Gender and layout arrangement preference in the narrative module type

Given that the P-Value is greater than 0.05 it can be concluded that the null hypothesis of independency is fails to be rejected. This is that, there is no association between gender and layout arrangement preference for adults between 25 and 35 years old with the narrative type module. The null hypothesis for homogeneity also fails to be rejected concluding that layout positioning preference is the same for female and males within the same age range for this module type. Tables 4.13 show the tabulated statistics for the young participant's and the narrative content modules.

Table 4-13 Tabulated Statistics Young Individuals: Gender and Narrative Module type

Rows: GENDER Columns: SCR POSITION					
	LU	RU	LL	RL	All
F	14	10	5	3	32
	21.88	15.63	7.81	4.69	50.00
M	4	14	9	5	32
	21.88	14.06	6.25	7.81	50.00
All	28	19	9	8	64
	43.75	29.69	14.06	12.50	100.00
Cell Contents: Count % of Total Pearson Chi-Square = 0.664, DF = 3, P-Value = 0.882 Likelihood Ratio Chi-Square = 0.669, DF = 3, P-Value = 0.880					

4.8.1.2 Gender and layout arrangement preference in the numerical module type

The P-Value for this case (as displayed in Table 4.14) is greater than 0.05 in this manner it can be concluded that the null hypothesis of independency fails to be rejected. This is that, there is no association between gender and layout arrangement preference for adults between 25 and 35 years old with the numerical type module. The null hypothesis for homogeneity also fails to be rejected concluding that the layout arrangement preference is the same for female and males within the same age range for this module type.

Table 4-14 Tabulated Statistics Young Individuals: Gender and Numerical Module type

Rows: GENDER Columns: SCR POSITION					
	LU	RU	LL	RL	All
F	14	8	6	4	32
	21.88	12.50	9.38	6.25	50.00
M	15	7	6	4	32
	23.44	10.94	9.38	6.25	50.00
All	29	15	12	8	64
	45.31	23.44	18.75	12.50	100.00

Cell Contents: Count % of Total
Pearson Chi-Square = 0.101, DF = 3, P-Value = 0.992
Likelihood Ratio Chi-Square = 0.101, DF = 3, P-Value = 0.992

4.8.1.3 Females and layout arrangement preference

Females layout arrangement preference also deployed a P-Value greater than 0.05 (table 4.15) therefore, the female population within the youngest group studied in both homogeneity and independency hypothesis prove insufficient information to be reject. By this, concluding that for young females' layout is indifferent regardless of the module type.

Table 4-15 Tabulated Statistics Young Individuals : Female arrangement preference

Rows: GENDER Columns: SCR POSITION					
	LU	RU	LL	RL	All
NARRATIVE	14	10	5	3	32
	21.88	15.63	7.81	4.69	50.00
NUMERICAL	14	8	6	4	32
	21.88	12.50	9.38	6.25	50.00
All	28	18	11	7	64
	43.75	28.13	17.19	10.94	100.00
Cell Contents: Count % of Total Pearson Chi-Square = 0.456, DF = 3, P-Value = 0.928 Likelihood Ratio Chi-Square = 0.457, DF = 3, P-Value = 0.928					

4.8.1.4 Males and layout arrangement preference

Similar to previous results males' layout arrangement preference depicted a P-Value greater than 0.05 (table 4.16) also proving insufficient information to reject both homogeneity and independency for the male population within the youngest group studied. By this, concluding that for young males' layout positioning preference is indifferent regardless of the module type.

Table 4-16 Tabulated Statistics Young Individuals: Male arrangement preference

Rows: GENDER Columns: SCR POSITION					
	LU	RU	LL	RL	All
NARRATIVE	14	9	4	5	32
	21.88	14.06	6.25	7.81	50.00
NUMERICAL	15	7	6	4	32
	23.44	10.94	9.38	6.25	50.00
All	29	16	10	9	64
	45.31	25.00	15.63	14.06	100.00

Cell Contents: Count % of Total

Pearson Chi-Square = 0.796, DF = 3, P-Value = 0.851
Likelihood Ratio Chi-Square = 0.799, DF = 3, P-Value = 0.850

4.8.2 Layout analysis for aging individuals (55 to 65 years old)

4.8.2.1 Gender and layout arrangement preference in the narrative module type

Given that the P-Value is greater than 0.05 (table 4.17), the null hypothesis of independency fails to be rejected. There is no association between gender and layout arrangement preference for adults between 55 and 65 years old when considering the narrative type module. The null hypothesis for homogeneity also fails rejection concluding that layout positioning preference is the same for female and males within the same age range for this module type.

Table 4-17 Tabulated statistics Aging Individuals: Gender and Narrative Module type

Rows: GENDER Columns: SCR POSITION					
	LU	RU	LL	RL	All
F	7	12	5	8	32
	10.94	18.75	7.81	12.50	50.00
M	5	16	5	6	32
	7.81	25.00	7.81	9.38	50.00
All	12	28	10	14	64
	18.75	43.75	15.63	21.88	100.00
Cell Contents: Count % of Total					
Pearson Chi-Square = 1.190, DF = 3, P-Value = 0.755 Likelihood Ratio Chi-Square = 1.195, DF = 3, P-Value = 0.754					

4.8.2.2 Gender and layout arrangement preference in the numerical module type

Similar to previous cases, the P-Value is greater than 0.05 (table 4.18), concluding that the null hypothesis of independency fails to be rejected. This is that, there is no association between gender and window positioning preference for adults between 55 and 65 years old with the numerical type module. The null hypothesis for homogeneity also fails rejection concluding that layout positioning preference is the same for female and males within the same age range for this module type.

Table 4-18 Tabulated Statistics Aging Individuals: Gender and Numerical Module type

Rows: GENDER Columns: SCR POSITION					
	LU	RU	LL	RL	All
F	16	7	7	2	32
	25.00	10.94	10.94	3.13	50.00
M	13	6	6	7	32
	20.31	9.38	9.38	10.94	50.00
All	29	13	13	9	64
	45.31	20.31	20.31	14.06	100.00
Cell Contents: Count % of Total					
Pearson Chi-Square = 3.242, DF = 3, P-Value = 0.356 Likelihood Ratio Chi-Square = 3.407, DF = 3, P-Value = 0.333					

4.8.2.3 Females and layout arrangement preference

Females' layout arrangement preference proved a P-Value smaller than 0.05 (table 4.19) meaning that the null hypothesis of independency and the null hypothesis for homogeneity are rejected. This is that, there is association between the layout arrangement preference and females 55 to 65 years old when exposed to different types of modules. Since independency and homogeneity hypothesis are rejected the degree of association between variables is determined by association measurements using Cramer's Coefficient and Contingency Coefficient. Females and layout preference proved to have a good association between variables through both Cramer and the Contingency Coefficient.

Table 4-19 Tabulated Statistics Aging Individuals: Female arrangement preference

Rows: GENDER Columns: SCR POSITION					
	LU	RU	LL	RL	All
NARRATIVE	7	12	5	8	32
	10.94	18.75	7.81	12.50	50.00
NUMERICAL	16	7	7	2	32
	25.00	10.94	10.94	3.13	50.00
All	23	19	12	10	64
	35.94	29.69	18.75	15.63	100.00
Cell Contents: Count % of Total					
Pearson Chi-Square = 8.771, DF = 3, P-Value = 0.032 Likelihood Ratio Chi-Square = 9.139, DF = 3, P-Value = 0.028 Coef- Conting Cramer 0.347173 0.370198					

4.8.2.4 Males and layout arrangement preference

Males' layout arrangement preference also depicted a P-Value smaller than 0.05 (table 4.20) meaning that the null hypothesis of independency and the null hypothesis for homogeneity are rejected. This can be interpreted as; there is association between the layout arrangement preference and males 55 to 65 years old when exposed to different types of modules. In this case similar to the previous case males and layout preference proved to have a good association between variables through both Cramer and the Contingency Coefficient.

Table 4-20 Tabulated Statistics Aging Individuals: Male arrangement preference

Rows: GENDER Columns: SCR POSITION					
	LU	RU	LL	RL	All
NARRATIVO	5	16	5	6	32
	7.81	25.00	7.81	9.38	50.00
NUMERICAL	13	6	6	7	32
	20.31	9.38	9.38	10.94	50.00
All	18	22	11	13	64
	28.13	34.38	17.19	20.31	100.00

Cell Contents: Count % of Total

Pearson Chi-Square = 8.269, DF = 3, P-Value = 0.041
Likelihood Ratio Chi-Square = 8.568, DF = 3, P-Value = 0.036

Coef-Conting	Cramer
0.338260	0.359448

This analysis reveals important findings that suggest that layout arrangement can be adjusted for both groups simultaneously accommodating their preferred layout arrangement when narrative content or numerical content is presented. Both genders within the youngest group studied demonstrated to have no layout arrangement preference when the type of module changed. The following charts may provide a better view of this last statement. Figure 4.10 and 4.11 show a high preference for the left upper position (LUP) by females and males from the first group (youngest) in both module types. The right upper position (RUP) was the second preferred by both genders leaving the lower left and right positions (LLP and RLP) as the less preferred layout arrangement. Layout arrangement preference selection for the lower left and right positions (LLP and RLP) was closely similar when the module viewed was numerical. For the narrative module type case, females preferred positions LLP over RLP opposed to males preference for these last two positions.

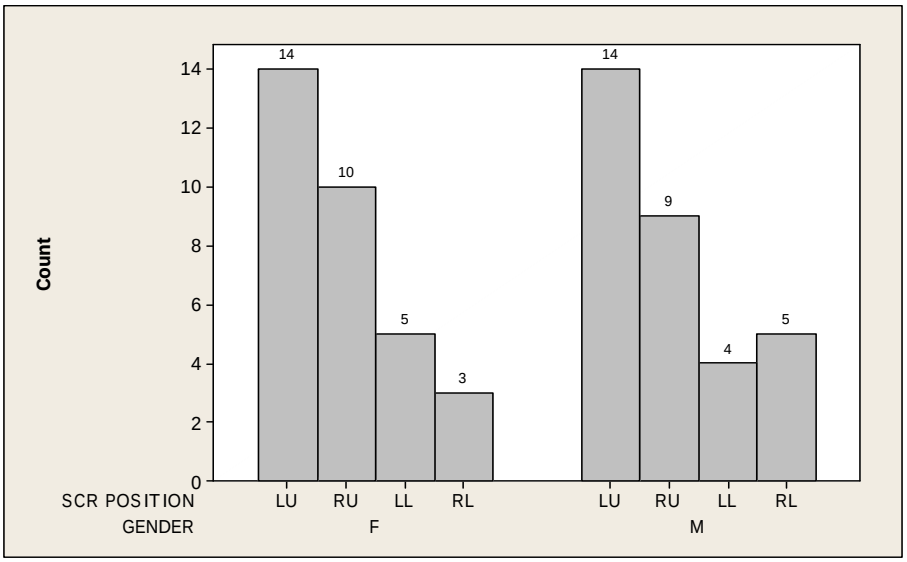

Figure 4-10 Gender and Layout Arrangement Preference in Narrative Modules for Young Individuals

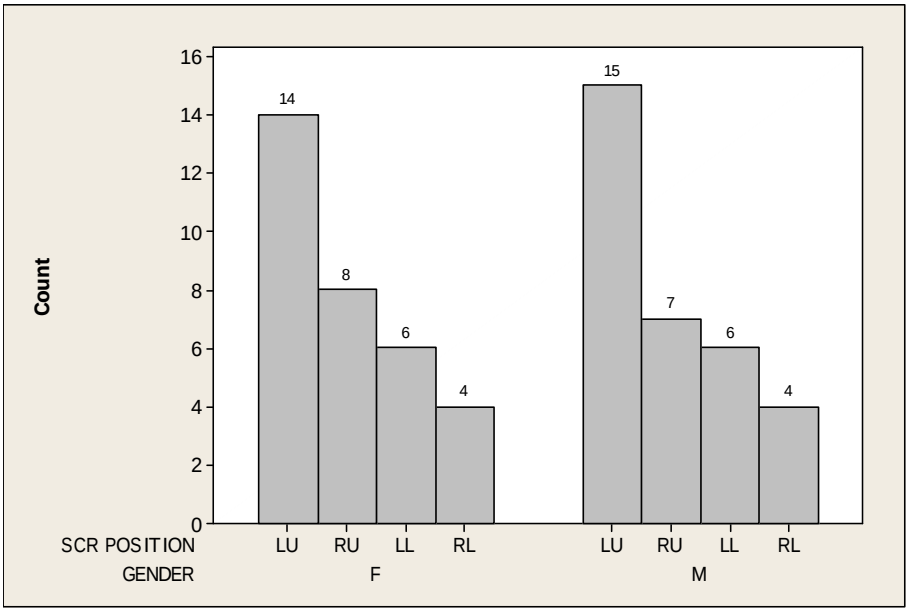

Figure 4-11 Gender and Layout Arrangement Preference in Numerical Modules for Young Individuals

In addition, Figure 4.12 presents females arrangement preference. Females from the youngest group demonstrated higher preference for the left upper position (LUP) over all other positions for both module types. Position upper right (RUP) was the second in order of preference, followed by positions LLP, and position RLP.

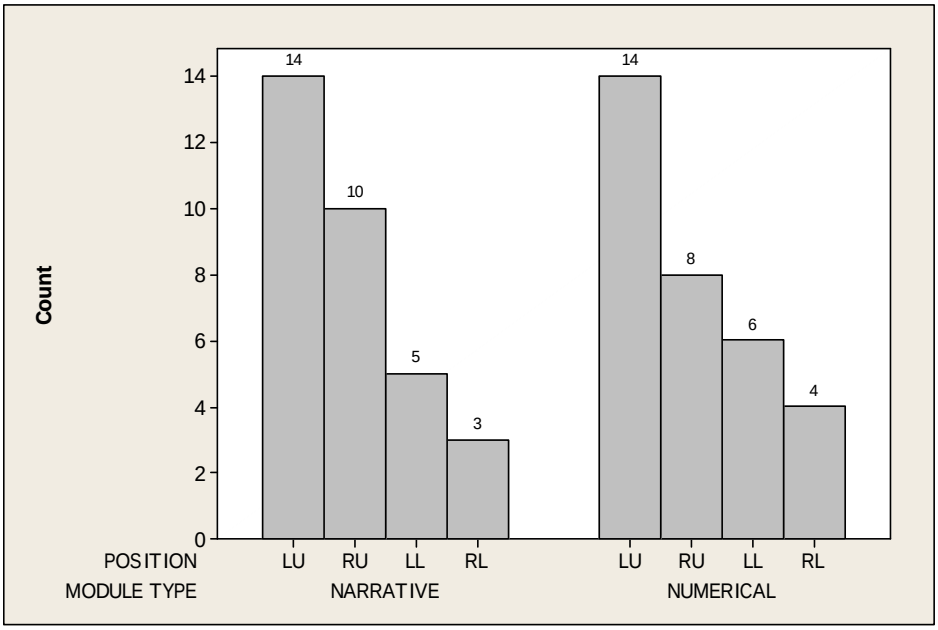

Figure 4-12 Female Layout Arrangement Preference for Young Individuals

Males also deployed the same preference position (Figure 4.13), left upper position, followed by right upper position. Males in the youngest group (25 to 35) differ from females in their last two preferred layout arrangements. They present higher preference for lower right position rather than the left lower position being this last position their less preferred overall arrangement when the content displayed is narrative.

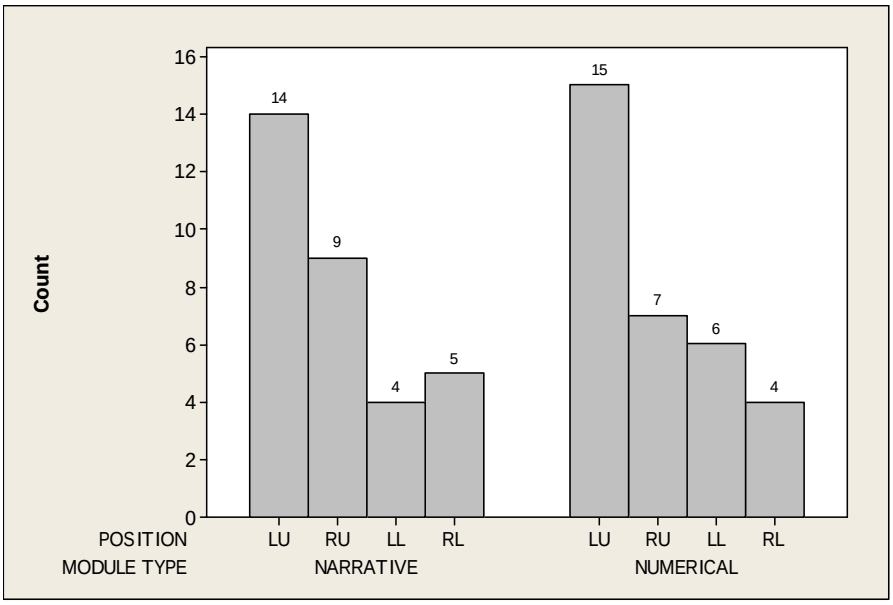

Figure 4-13 Male Layout Arrangement Preference for Young Individuals

Figures 10, 11, 12 and 13 illustrate layout preferences in the youngest group, individuals between 25 and 35 years old. Figures displayed below, Figures 14, 15, 16 and 17 illustrate preferences for the aging group, individuals between 55 and 65 years old. This second group showed differences in layout arrangement preferences between modules type and gender. Figure 4.14 displays the layout arrangement preference for the narrative module type, denoting higher levels of preference for the upper right position (RUP).

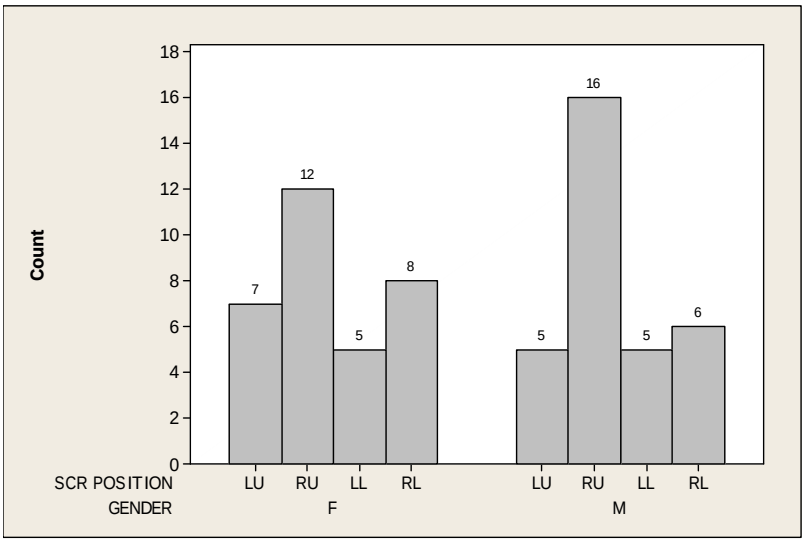

Figure 4-14 Gender and Layout Arrangement Preference in Narrative Modules for Aging Individuals

Position (LU) remained as number one preferred by both genders in aging group as well as previously identified in the youngest group in the numerical module type (Figure 4.15).

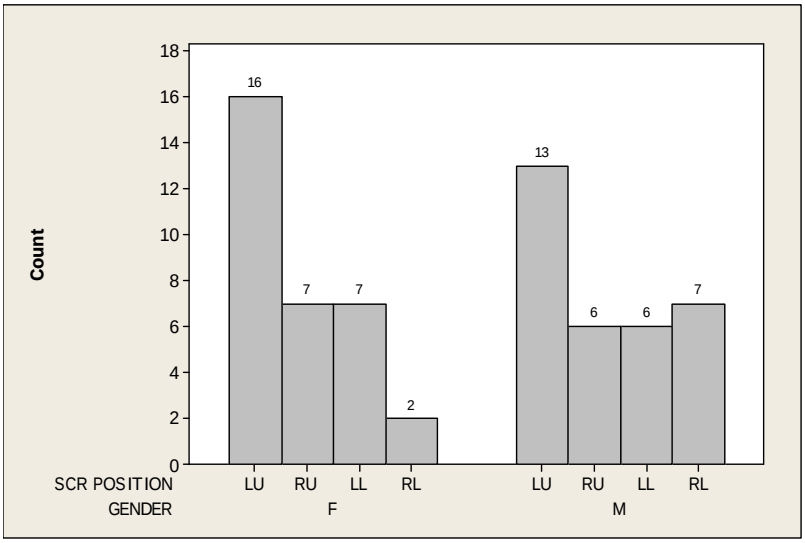

Figure 4-15 Gender and Layout Arrangement Preference in Numerical Modules for Aging Individuals

The Figures 4.16 and 4.17 show differences within females and males in the aging group (55 to 65) layout arrangement preference for both module content types, narrative and numerical. They are both inclined to the right upper position when viewing the narrative module type and left upper position when viewing the numerical module.

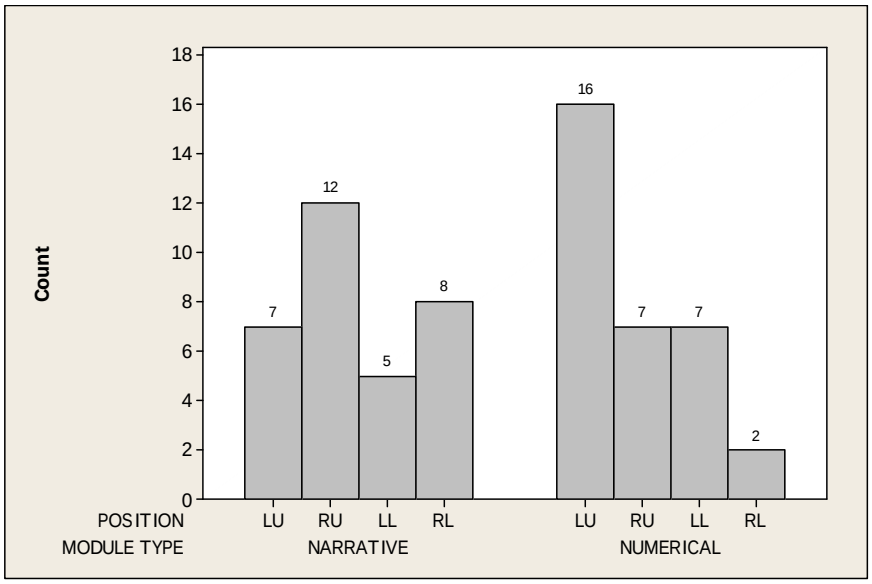

Figure 4-16 Female Layout Arrangement Preference for Aging Individuals

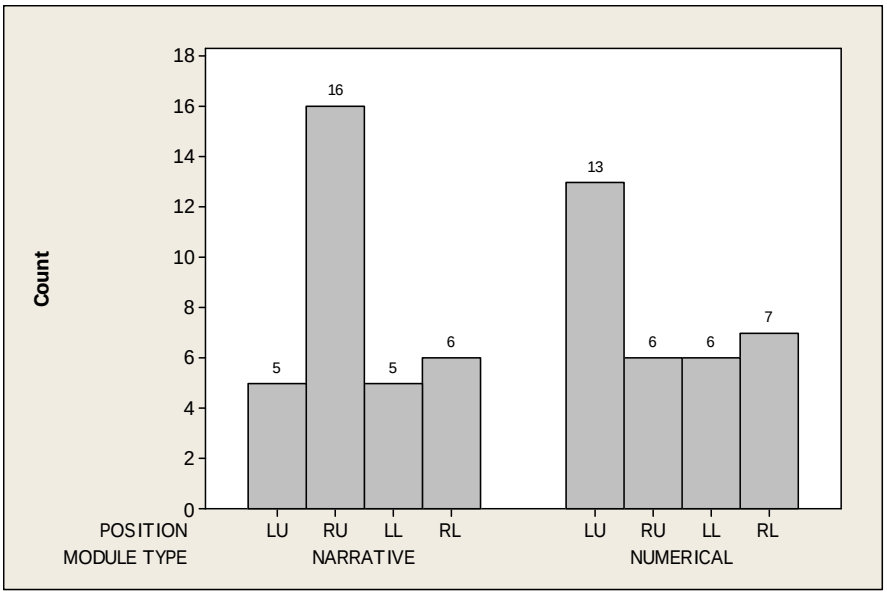

Figure 4-17 Males Layout Arrangement Preference for Aging Individuals

4.9 Participant Experience Value and Final Comments Review

When the experimental tasks concluded, participants had the chance to comment and value their experience first selecting within a set of adjectives the words that would most likely describe their experience. After defining their experience through this selection, participants had to select within the set of words they had chosen the 5 words that would most closely describe their experience and rank order them. Adjective number one was the most closely to describe their experience decreasing up to completing the 5 words.

This final task was meant to collect information regarding the participants experience as a whole, not just their feelings towards the courses but their overall experience from the arrival, procedure instructions and task execution. Table 4.21 contains the list of adjectives from where participants were able to select.

Table 4-21 List of Adjectives for the Participants Experience Valuation

Fascinating	**F**	Tiresome	**P**	Routine	**Rou**
Boring	**B**	Simple	**S**	Good	**G**
Respectful	**Res**	Gives a Sense of Realization	**R**	Pleasant	**Pl**
Creative	**Cr**	Useful	**Usf**	Frustrating	**Fru**
Challenging	**Ch**	Endless	**Int**	Satisfying	**Sat**

The younger participant's group valuated their experience to be in first place very simple, useful and boring. In second and third place they valued their experience as satisfying and good. Their fourth selection included the adjectives routinely, endless and useful. Their last selection ordering the selected adjectives described their experience as routinely, satisfying, respectful and frustrating. It is interesting to note as presented in Figure 4.18 that younger users did not describe their experience as fascinating or pleasant on the contraire their experience was quite simple, consistently routinely and somewhat useful. Although they seem to leave with a respectful, good and satisfying experience they did not appear to be impressed by creativity, challenge or the sense of realization.

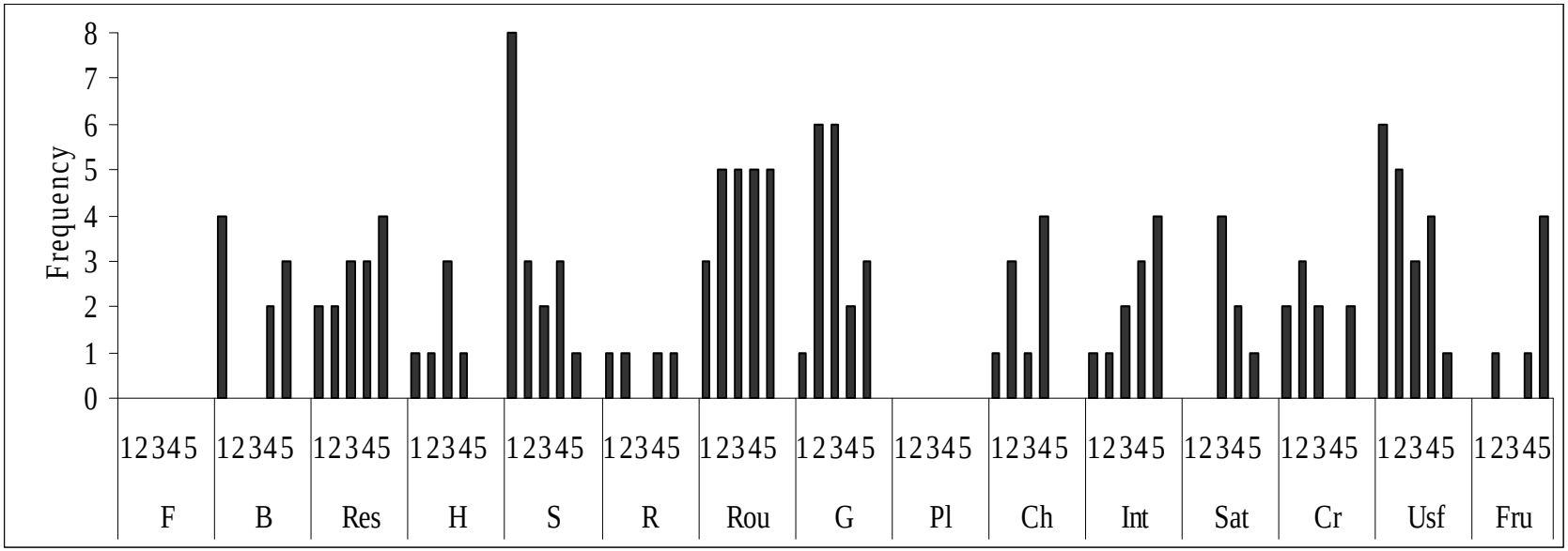

Figure 4-18 Experience Valuation by Young Individuals

Aging participants valuated their experience in first place as good, useful and respectful. In second place they would describe their experience as useful but also creative. Satisfaction was first to be in the adjectives listed in third place that could describe their feelings towards the activities they had just performed. Challenging, good and useful as well as simple complete the last fourth and fifth placement of words by which the oldest sample set described their feelings (Figure 4.19).

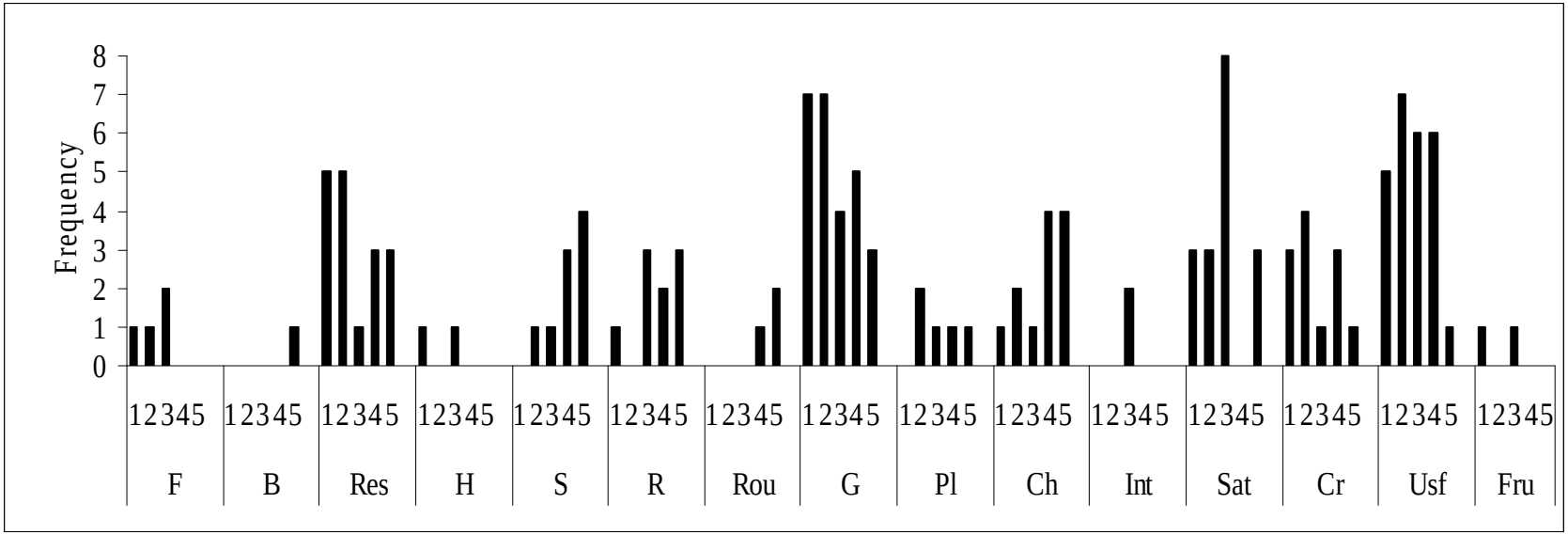

Figure 4-19 Experience Valuation by Aging Individuals

Figure 4.20 presents a summary of rankings for both sets. Notice that the differences among the two sample sets are perceptible with the group of adjectives employed by each group to describe their experience. While the youngest sample set described their experience as very simple, boring, routinely, endless, frustrating and finally good, useful, satisfying, respectful the aging group focused on the adjectives such as good, useful, respectful, creative, satisfying, challenging and simple.

Young:	**Aging:**
Simple, useful and boring(1) Satisfying, good(2-3) Routinely, endless and useful(4) Respectful, routinely, satisfying and frustrating(5)	Good, useful and respectful (1) Useful and creative (2) Satisfying(3) Challenging, good, useful and simple(4-5)

Figure 4-20 Experience Valuation: Ranking Summary of Young and Aging Participants

Comment review could provide a clearer view of what is previously exposed. These comments were translated from their original version, from Spanish to English. All comments were faithfully transcribed as they were written in their Spanish version (Appendix E). Comments listed below suggest that young participants and aging participants did have a very different experience and have very clear differences regarding the design preferences.

Younger Individuals (25 to 35 years old)

"Boring content, would like more images, do not like the female instructor"

"Used correct development tools"

"Would like more interaction without taking away what it presents, routinely task, and useful information"

"Interesting the challenge to have to remember content"

“Did not like to have unidirectional dynamic, like to see more movement in the video, more illustrations and larger size of video”

“Did not like that I cannot adjust the speech speed it turns endless and frustrating”

“Video was boring I liked that there was enough information to read. The banner was the most useful part”

“The banner effects of flashes recaptured my attention when new concepts were exposed”

“Very up to date investigation”

“I would liked more pauses to think about what the instructor had just said”

“The dynamic was very interesting… but four times was boring”

“Boring. Liked the green and body focus”

“Preferred the male instructor. Would like more colors”

“Could not establish a method to remember lots of numbers”

“The course was challenging and creative but in most part it was boring and too repetitive”

“Got frustrated with the small video. Preferred the male instructor”

“Dislike the small video”

Aging Individuals (55 to 65 years old)

"Good illustration and very easy to follow"

"There was too much visual information and the instructors had a rapid speech speed"

"Preferred the larger size video and the PowerPoint presentation"

"Interesting course very well exposed and the visuals were perfect"

"Written content skipped very fast"

"Preferred the women instructor"

"Pleasant, useful, I learned a lot. The images and text was clear and well exposed"

"I prefer the female instructor".

"I consider the course and the tasks performed important, respectful"

"Banner can be omitted or eliminated"

"Content was precise and very well exposed it went direct to the point and to be able to see it several times assures that I did learn the content"

"The presentation skipped very fast but overall it was a good experience"

"Did not even read the banner, never got a chance. The text size can always be bigger. The speech speed can always be more paused"

"I prefer the female instructor. It was very challenging to remember the content and the classroom background was completely distracting"

"It was very educating. The colors were fine but it was too hard to remember the content"

While most young participants expressed that the modules were designed using appropriate development tools, good illustrations, good attention capturing effects such as banner effects, camera focus adjustments and the male instructor all which were “liked” and summed to a good experience. The sedentary requirements, unidirectional dynamic of the course and repetitions due to the experiment design requirements had a strong influence by not cooperating to produce a good experience. Overall young individuals expressed that a more colorful, with large video display and a male guide as an instructor, having an adjustable speech speed for the instructor and a space for pauses was desired in this type of course or training.

Aging participants on the other hand were quite pleased with the repetitions as it helped them “remember and learn more” the content. Text size, colors and images were also a plus to having a positive experience. No hesitation seemed to unveil their dislikes when they expressed what they would desire in a course or training with this modality. This is that, in addition to what was presented aging individuals felt that the speech speed was too accelerated as well as the written content. For these modules about verbally expressed content was about 135 words per minute. Take for example the banners content for which some claimed “Did not even read...” explaining why perhaps some felt that some written information such as the banners “...can be omitted or eliminated”. The female instructor was also a more “liked” rather than the male instructor.

Figure 4.21 displays a summary of the open valuation exercise for both sample sets divided in several sections: things they like, dislike, prefer and other comments.

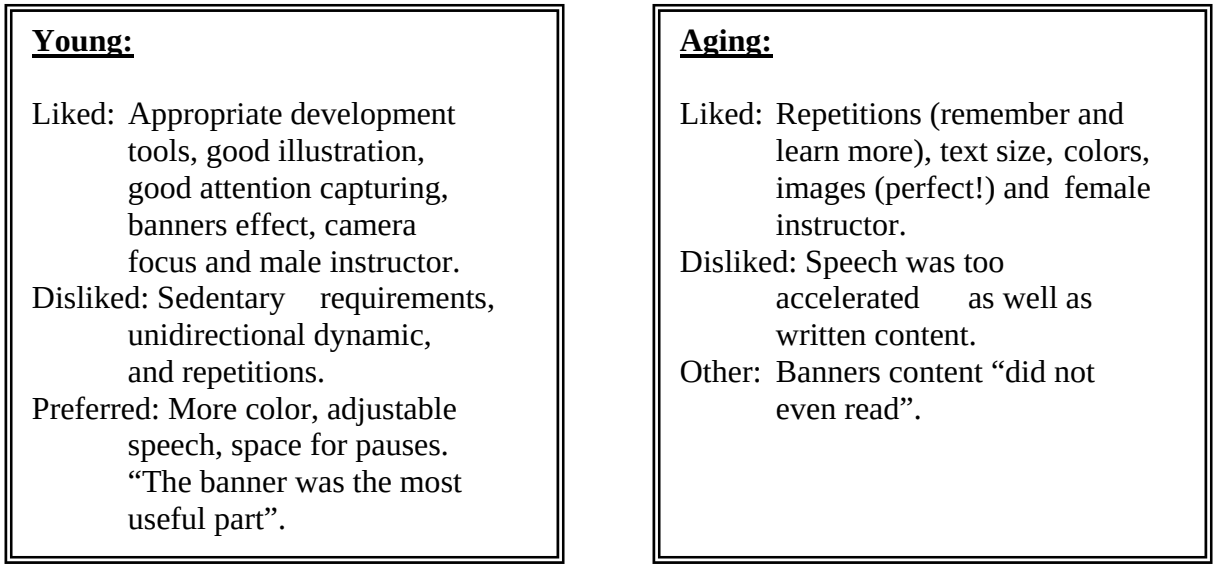

Figure 4-21 Experience Valuation: Comment Summary of Young and Aging Participants

5 CONCLUSIONS

The main purpose of this research was to conduct a controlled experimental study that would provide insight to develop design guidelines for Web-based E-Learning and E-Training courses that will provide effective and quality educational modules.

The controlled experiment design revealed that lesson content type, environment simulator, size and age are significant and therefore have great importance when information recall of the material displayed in an online course or training is a goal or will become a form of measuring student or employee success. Main effects plots (Figure 4.1) showed that when the module type is narrative, there is a studio simulator background, and the video display is large and with the younger sample set information recall increased.

Age and the type of module proved to make a significant difference in the satisfaction levels resultant from the task experience. Comparison across the levels of the significant factors (the plots in Figure 4.2) show that satisfaction increases when module type is narrative and satisfaction was significantly higher for older individuals than for younger individuals. For the disorientation variable experiment exposed that Age, Content Type and Content Type*Age are significant. Age and Content Type*Age interaction were the only sources that proved a significant difference in the Task Load response levels. Task Load levels were found to be higher for young individuals than for older individuals. This result is coherent with the results from the satisfaction variable were younger individuals were less satisfied with the course than older individuals.

The filming techniques employed in the creation of the course or training video had a significant impact in the recall variable measured through information recall. The environment simulator (classroom simulator background and studio simulator background)

and the video size (small and large) affected the response, information recall. Also, main effects plot presents an increase in recall when there is no background (studio simulator background) or a plain color background and the video display is in its larger size.

The information recalled by the individuals whether it was the narrated by the instructor, the banner content or the PowerPoint presentation varied depending on the module type whether it was narrative or numerical and the Age factor.

Narrative content type modules deployed a higher average value of recalled words from what was orally expressed by the instructor for both young and aging participants. Banners reached similarly high values compared to the PowerPoint presentation content recall for the younger participants. PowerPoint presentation did not have a significant contribution in the information recalled. Aging participants responded differently recalling more information from the PowerPoint presentation with respect to the banners, although they seem to have very similar values. For the numerical module type the amount of information recalled of the three information sources in the course interface change. PowerPoint presentation and what was orally expressed by the instructor shows a nearly indistinguishable line implying that the average values of words recalled were merely the same for these two sources. This result applies to both age sets studied. In both sample sets the information recalled from the banners was very low but as young individuals recall none or just few words from the banners in the numerical modules aging individuals in the narrative modules slightly remember words while

young participants recall shortly its content. The amount of recalled words from each source is similar when comparing each type of module with the different video sizes (narrative module with small video display and narrative module type with large video display and numerical module with small video display and numerical module type with large video display). This may imply that the video size is not related to the selection of information (provided by the different sources) the individual is able to recall. For both, narrative and numerical modules with simulated classroom background and plain background videos, the results revealed the same conclusions than the deployed with the different video sizes. Small video display and the simulated classroom video background as well as modules that contain videos with plain background exhibit equal results than the large video displays.

Age was the last mentioned factor to prove to be significant in the information recalled by participants. There is a noticeable difference between the amounts of recalled words by both sets. Young individuals recalled more information from almost all sources with the exception of the banners in the narrative cases but although aging individuals recalled less words from the modules overall content they managed to retain from all sources, this not being the case of young individuals who in some cases recalled just a few or no word from the banners.

To continue with the sequence of hypothesis conclusions, the instructors' gender did not prove through the designed experiment to be significant in the information recall attained by

participants, the level of satisfaction produced by each module nor did it have any effect in the levels of disorientation or task load.

Finally layout arrangement preferences differ based on lesson content (numerical compared to narrative information), age and gender. The following Table 5.1 summarizes the layout analysis results:

Table 5-1 Layout Arrangement Preferences Results Summary

Layout preferences by:	Group 1 (Young) (Hypothesis)		Group 2 (Aging) (Hypothesis)	
	H_o	H_a	H_o	H_a
Narrative Module Type	✓	Rejected	✓	Rejected
Numerical Module Type	✓	Rejected	✓	Rejected
Female Preference	✓	Rejected	Rejected	✓
Male Preference	✓	Rejected	Rejected	✓

For the first group described as the youngest group (25 to 35 years old individuals) the gender and layout arrangement preference in the narrative module type revealed that there was no association between gender and layout arrangement preference for adults between 25 and 35 years old with the narrative type module. Therefore accepting the null hypothesis of independence and concluding that, layout positioning preference is the same for female and

males within the same age range for this module type. The numerical content module type also concluded in the acceptance of the null hypothesis of independency as well as the null hypothesis of homogeneity concluding that the layout arrangement preference is the same for female and males within the same age range for this module type. Females and males within this younger group also proved homogeneity and independence by this concluding that for young females and males the layout preference is indifferent regardless of the module type.

The second group, referred also as the aging group (55 to 65 years old individuals) results were similar to previously exposed in the young age group. Gender and layout arrangement preference in the narrative module type as well as numerical content module revealed there is no association between gender and layout arrangement preference for adults between 55 and 65 years old when considering the both lesson content type. This is, both independence and homogeneity null hypothesis failed to be rejected. This leads to conclude that the null hypothesis for homogeneity also fails to be rejected indicating that layout positioning preference is the same for female and males within the same age range despite the module type.

Females and males within the aging group individuals (55 to 65 years old) on the other hand did have differences proving a determined preferred layout arrangement with the different lesson content type. In other words for both cases the null hypothesis of independency and the null hypothesis for homogeneity is rejected. This is that, there is association between the

layout arrangement preference and females and males 55 to 65 years old when exposed to different types of modules. In both cases the degree of association was good between variables through both Cramer and the Contingency Coefficient.

This analysis reveals important findings that suggest that layout arrangement can be adjusted for both groups simultaneously accommodating their preferred layout arrangement when narrative content or numerical content is presented. Both genders within the youngest group studied demonstrated to have the same layout arrangement preference when the type of module changed.

Independent of age group, the participants preferred to place the video in the upper part of the display or screen. Layout arrangement preference for the youngest group was inclined towards the top of the display in the left (LUP) position for both module types followed by the right side (RUP). The aging group showed differences in layout arrangement preferences between module type and within the gender. For aging users, narrative module type denoted higher levels of preference for right side of the screen position (RUP), while the video in the upper left side position (LUP) remained as number one preferred by both genders in this last group as well as previously identified in the younger participants for the numerical module type.

6 DISCUSSION

Aging is an inevitable biological process. Although aging effects cannot be reversed, the aging pace in declining functions can by mitigated by human factors and understanding how human and computer interaction works. After reading the conclusions it is easy to picture a partially blank Web application with a few necessary links, no scrolling but clicking to go to further pages, severely high contrast, center oriented layout, black sans serif size letters 18 or larger and it does not seem very appealing in a world of multi-taskers and fast technology generation.

The controlled experiment design revealed that an interface that ensures high levels of satisfaction and information recall as well as low levels of disorientation and task workload could be accomplished only partially if both age range segments were to be target simultaneously with the same type of module. This module's type of interface would be one that presents the information in a more narrative format than computational or numerical, that presents a video with a studio simulator background, a large video display, large letter size (18 points or larger) and limited and discrete use of colored text avoiding it when possible.

The partial success of this design in terms of the dependent variables listed above may be explained with the interesting differences that the data analysis revealed. While young

individuals prefer a male instructor, more images, and a have a single layout arrangement preference regardless of the type of content that is being presented, aging individuals tend to prefer the female instructor, have different preferences depending on the type of content that is presented and found the amount of images and illustration techniques “perfect”.

As expected due to the aging pace declining cognitive functions the younger participants had a significantly higher level of information recall than older individuals. When the information recalled by both sets was broken down to determine the specific parts or elements composing the interface from which participants recalled certain information findings were very surprising. In the narrative content type modules information that was orally expressed by the instructors received priority over all information recalled for both sets of volunteers. Then something interesting happened, younger participants recalled more information from the banners and very little information from the PowerPoint presentation. Aging participants on the contraire recalled a high amount of words from the PowerPoint presentation and very little information from the banners. In the numerical or computational content type, aging and young individuals present a nearly indistinguishable chart line that represents nearly no difference in the amount of word recalled from the information that was expressed orally by instructors and the PowerPoint presentation leaving banners with a very noticeable low amount of words recalled. In addition video size as well as background made no difference in the amount of words that were recalled from each information source or element composing the interface.

This finding corroborates the accumulation of knowledge theory (Westerholm and Kilborn, 1997) (Kowalski-Trakofler et al., 2005) leaving the biological declining function theory (Cronholm and Schalling, 1988; Burke and Mackay, 1997; Rabbitt and Lowe, 2000) perhaps brought up to further test or revision. This is that, the accumulation of knowledge and experience leads to an increase in skills with age instead of suggesting that the decline in biological functions affects the ability to learn and to perform many work related tasks. In the information recall task the fact that younger adults recalled more information than their aging counterparts may have proved the biological declining function theory. In fact, while the younger group registered high levels of recall for only two sources of information from the interface, aging individuals managed to recall a significant amount of words from all sources of information. Although the levels of recall for the aging group were lower, it appears attention, information processing and working memory capabilities had a very low effect towards the negative side even when in some cases they expressed that the amount of displayed elements was overwhelming.

Experience valuation and comments substantiate the design strategy to follow when designing for these population sets. Although the younger sample set requested “more” not proving through the information recall task that they were capable of dividing in an equivalent way their attention, information processing and working memory capabilities to recall from all information sources in the interface, the aging individuals requested “less” perhaps understanding they could deploy better results if less was displayed.

In deed as Mies van der Rohe (date) said “less is more”, the key is to “keep it simple” and remove the visual noise. Bernard et al. (2000) believed that open space can increase satisfaction. Nielsen (Nielsen, 1999) has suggested simplicity as a key factor behind the creation of usable designs. He considered it as the lack of obstruction or complexity. Tufle (1990) stated “it is not how much space there is, but rather how the information is used”.

This study proved that it is not convenient to design for both age range sets because high levels of the satisfaction, recall and low levels of disorientation and task workload may not be assured for all as Hawthorn (Hawthorn, 2000) believed (designers must target a specific population). This statement may suggest that the appropriate strategy is design focusing in each group but the present study suggest that customization may be the best option. If we design for each group, especially for the aging, an erroneous practice may be to build a restricted interface or computer environment to eliminate misunderstanding and executing undesired actions, when the goal should be to use natural constrains such as common life restrictions (Burrell and Sodan, 2006). This said, another discussion arises placing this best option as a management investment decision. This is because customization is expensive and recovery of the investment may only be perceived as an improvement in satisfaction, performance, productivity and other subjective measures in an indefinite horizon time.

Therefore there will be a constant need for updates and learning assessment. However, training in general is an undisputable necessity for all companies as well as providing online services by universities. Considering this study's findings, customizing for the population in question will provide an equitable use of resources considering differences among the student and employees, a simple and easy to understand interface regardless of the student-employees computer experience and background, minimizes hazards and the adverse consequences of accidental or unintended actions, physical effort considerations and may increase the possibly of minimizing the horizon time of investment return.

7 RESEARCH CONTRIBUTIONS AND FUTURE WORK

7.1 Research Contributions

This study provided design criteria against the universal approach. It revealed significant differences between two groups of individuals providing insight of specific preferences regarding factors such as layout arrangement, speech pace and instructor's gender. The experimental groups were at both extremes of the age spectrum. In addition, this experiment and its results may serve as a screening experiment for future studies, revealing other significant factors associated with this study's dependent variables.

This investigation revealed significant recall information factors, and significant satisfaction and task load factors. Also this research introduced the analysis of simultaneous criteria developed in separate manner in other studies. The characteristics with which these models were constructed that includes the experiment independent variables in addition to the design criteria as summarized and classified in this study (Figure 1.1) produce low levels of disorientation for which no significant factors were revealed. This study introduced for the first time television production concepts to DL with the collaboration of a prestigious national television channel. In addition, the research enabled the identification of important interface sources of information for relevant information transmitting. Within the design strategies two different methods for two different follow-up strategies were developed (index and banner effects). The banner development represents a new way to convey relevant information without recurring to presentations in slide format using PowerPoint.

Finally, experience valuation and written comments provide a closer view of how participants perceived an asynchronous course or training exhibiting the design criteria considered for the module production of this study

7.2 Future Work

Important pathways open to continue investigating factors that may influence the studies dependent variables. Future work may be oriented to validating the results for each age segment to maintain all four dependent variables at desired levels considering study's findings. Moreover, independent variables may be extended to application and learning of content.

It is of great importance to identify the young and aging individual's preferences for the interface components and design as it has been exposed in this study, as well as understanding the motives behind these preferences. Young individuals prefer a male instructor, more images, and have a single layout arrangement preference regardless of the type of content that is being presented. Aging individuals tend to prefer the female instructor, have different preferences depending on the type of content that is presented and found the amount of images and illustration techniques "perfect" and so on. There are other characteristics that may be tested concerning the video production such as backgrounds that contain a more realistic or naturalistic environments, this may include students or a working environment. Also, even when important design criteria were considered to accommodate the aging in the modules design for this study, further studies may focus on the effects of more feedback techniques such as sounds, alarms, and messages.

Identifying user preferences is important; future studies should also pursue understanding the motives behind these preferences in the search for efficiency and appropriate accommodation of the target population.

Other types of instructional environments may be tested such as backgrounds that contain a more realistic scene (this may include students or a working environment). Also, even when important design criteria were considered to accommodate the aging in the modules design for this study, further studies may focus on the effects of more feedback techniques such as sounds, alarms, messages.

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APPENDIX A DEMOGRAPHIC AND LEARNING STYLE QUESTIONS

Demographic Data
(Original language was preserved to avoid translation errors)

A continuación aparecerán varias secciones de preguntas por favor seleccione la respuesta que más lo represente. Usted deberá completar todas las preguntas para poder proceder a la siguiente página.

1 Nombre de usuario: _____
2 Género: __Femenino __Masculino
3 Ocupación: __Estudiante __Empleado __Retirado
4 ¿A que programa pertenece? Subgraduado Graduado Doctoral
5 Departamento y especialidad_____
7 ¿Ha tomado cursos o entrenamientos en línea? ___Si___No (saltar a 8 si la respuesta es Sí. Si no salte a 11)
8 ¿Cuáles eran los temas tratados en los cursos o entrenamientos?
9 ¿Cual fue la modalidad en que se presentó?
____Sincrónico (El instructor y estudiante comparten el mismo tiempo y distinto espacio. Ej. Sistemas de Videoconferencia)
____Asincrónico (Separación de espacio y tiempo)
10 En su experiencia con cursos en línea o entrenamientos, el uso de la tecnología para el desarrollo del mismo fue:
___Extremadamente pobre ___Muy pobre ___Buena ____Muy buena ____Excelente
11 Su experiencia en el uso de computadores es de:
--seleccione uno—
Menos de 1 año 1 año 2 años 3 años Entre 4 y 5 años Más de 5 años
12 Al usar nuevas tecnologías, suele sentirse:
__Extremadamente Incómodo __Muy incómodo __Moderadamente cómodo __Muy cómodo ___Extremadamente cómodo

Learning Styles Inventory

Please choose only one answer for each question. If both “a” and “b” seem to apply to you, choose the one that applies more frequently.

1. I understand something better after I
   (a) try it out.
   (b) think it through.
2. I would rather be considered
   (a) realistic.
   (b) innovative.
3. When I think about what I did yesterday, I am most likely to get
   (a) a picture.
   (b) words.
4. I tend to
   (a) understand details of a subject but may be fuzzy about its overall structure.
   (b) understand the overall structure but may be fuzzy about details.
5. When I am learning something new, it helps me to
   (a) talk about it.
   (b) think about it.
6. If I were a teacher, I would rather teach a course
   (a) that deals with facts and real life situations.
   (b) that deals with ideas and theories.
7. I prefer to get new information in
   (a) pictures, diagrams, graphs, or maps.
   (b) written directions or verbal information.
8. Once I understand
   (a) all the parts, I understand the whole thing.
   (b) the whole thing, I see how the parts fit.
9. In a study group working on difficult material, I am more likely to
   (a) jump in and contribute ideas.
   (b) sit back and listen.
10. I find it easier
   (a) to learn facts.
   (b) to learn concepts.
11. In a book with lots of pictures and charts, I am likely to
   (a) look over the pictures and charts carefully.
   (b) focus on the written text.
12. When I solve math problems
   (a) I usually work my way to the solutions one step at a time.
   (b) I often just see the solutions but then have to struggle to figure out the steps to get to them.

13. In classes I have taken
(a) I have usually gotten to know many of the students.
(b) I have rarely gotten to know many of the students.
14. In reading nonfiction, I prefer
(a) something that teaches me new facts or tells me how to do something.
(b) something that gives me new ideas to think about.
15. I like teachers
(a) who put a lot of diagrams on the board.
(b) who spend a lot of time explaining.
16. When I'm analyzing a story or a novel
(a) I think of the incidents and try to put them together to figure out the themes.
(b) I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.
17. When I start a homework problem, I am more likely to
(a) start working on the solution immediately.
(b) try to fully understand the problem first.
18. I prefer the idea of
(a) certainty.
(b) theory.
19. I remember best
(a) what I see.
(b) what I hear.
20. It is more important to me that an instructor
(a) lay out the material in clear sequential steps.
(b) give me an overall picture and relate the material to other subjects.
21. I prefer to study
(a) in a study group.
(b) alone.
22. I am more likely to be considered
(a) careful about the details of my work.
(b) creative about how to do my work.
23. When I get directions to a new place, I prefer
(a) a map.
(b) written instructions.
24. I learn
(a) at a fairly regular pace. If I study hard, I'll "get it."
(b) in fits and starts. I'll be totally confused and then suddenly it all "clicks."
25. I would rather first
(a) try things out.
(b) think about how I'm going to do it.

26. When I am reading for enjoyment, I like writers to
(a) clearly say what they mean.
(b) say things in creative, interesting ways.
27. When I see a diagram or sketch in class, I am most likely to remember
(a) the picture.
(b) what the instructor said about it.
28. When considering a body of information, I am more likely to
(a) focus on details and miss the big picture.
(b) try to understand the big picture before getting into the details.
29. I more easily remember
(a) something I have done.
(b) something I have thought a lot about.
30. When I have to perform a task, I prefer to
(a) master one way of doing it.
(b) come up with new ways of doing it.
31. When someone is showing me data, I prefer
(a) charts or graphs.
(b) text summarizing the results.
32. When writing a paper, I am more likely to
(a) work on (think about or write) the beginning of the paper and progress forward.
(b) work on (think about or write) different parts of the paper and then order them.
33. When I have to work on a group project, I first want to
(a) have "group brainstorming" where everyone contributes ideas.
(b) brainstorm individually and then come together as a group to compare ideas.
34. I consider it higher praise to call someone
(a) sensible.
(b) imaginative.
35. When I meet people at a party, I am more likely to remember
(a) what they looked like.
(b) what they said about themselves.
36. When I am learning a new subject, I prefer to
(a) stay focused on that subject, learning as much about it as I can.
(b) try to make connections between that subject and related subjects.
37. I am more likely to be considered
(a) outgoing.
(b) reserved.
38. I prefer courses that emphasize
(a) concrete material (facts, data).
(b) abstract material (concepts, theories).

39. For entertainment, I would rather
(a) watch television.
(b) read a book.
40. Some teachers start their lectures with an outline of what they will cover. Such outlines are
(a) somewhat helpful to me.
(b) very helpful to me.
41. The idea of doing homework in groups, with one grade for the entire group,
(a) appeals to me.
(b) does not appeal to me.
42. When I am doing long calculations,
(a) I tend to repeat all my steps and check my work carefully.
(b) I find checking my work tiresome and have to force myself to do it.
43. I tend to picture places I have been
(a) easily and fairly accurately.
(b) with difficulty and without much detail.
44. When solving problems in a group, I would be more likely to
(a) think of the steps in the solution process.
(b) think of possible consequences or applications of the solution in a wide range of areas.

APPENDIX B SATISFACTION QUESTIONNAIRE

Each of the statements below the scales corresponds to something that a person might say about taking an online course. Please indicate your own personal *feelings* about your experience by selecting the number that expresses how much you agree with each of the statements.

How much do you agree with this statement?

1	**2**	**3**	**4**	**5**	**6**	**7**
Disagree Strongly	Disagree	Disagree Slightly	Neutral	Agree Slightly	Agree	Agree Strongly

_____1. The course was usually interesting enough to keep me from getting bored.

How satisfied are you with this aspect of the course?

1	**2**	**3**	**4**	**5**	**6**	**7**
Extremely Dissatisfied	Dissatisfied	Slightly Dissatisfied	Neutral	Slightly Satisfied	Satisfied	Strongly Satisfied

_____2. The amount of independent thought and action I could exercise in this course.
_____3. The screen layout you selected.
_____4. The video size displayed.
_____5. The video image displayed.
_____6. The content of the lesson.

To what extent did these characteristics affect the overall Mental Demand required to take this course?

1	**2**	**3**	**4**	**5**	**6**	**7**
Very Much Unaffected	Unaffected	Slightly Unaffected	Neutral	Slightly Affected	Affected	Very Much Affected

_____7. Uncertainty in task instructions and procedures.
_____8. Use and design of the computer interface (independent of the kind of work you did for the comprehension task).
_____9. The performance level you were asked to achieve.
_____10. The video size displayed.
_____11. The screen layout you selected.
_____12 The video image displayed.

APPENDIX C DISORIENTATION QUESTIONNAIRE

Please select the response that best indicates your feelings.

1) Given a question that could be answered from the lesson, how easily do you feel you could find the answer in the lesson?

Not Easily Very Easily

1 2 3 4 5

2) How much confusion did the organization of the lesson produce in you?

None Very Much

1 2 3 4 5

3) Given a major concept contained in the lesson how easily do you feel you could locate that concept?

Not Easily Very Easily

1 2 3 4 5

4) How often did you sense a feeling of being lost in the lesson?

Never Always

1 2 3 4 5

5) While studying the lesson, how comfortable were you with its structure or organization?

Very Uncomfortable Very Comfortable

1 2 3 4 5

6) How often were you unsure of where to go next in the lesson?

Never Always

1 2 3 4 5

7) How often were you aware of where you were in the lesson relative to other, related concepts?

Never				Always
1	2	3	4	5

8) How often were you confused as to where you had already been in the lesson?

Never				Always
1	2	3	4	5

9) To what degree do you feel the organization of the lesson was logically arranged?

Not at all				Very Much
1	2	3	4	5

10) How often were you unsure of how you arrived at a given topic in the lesson?

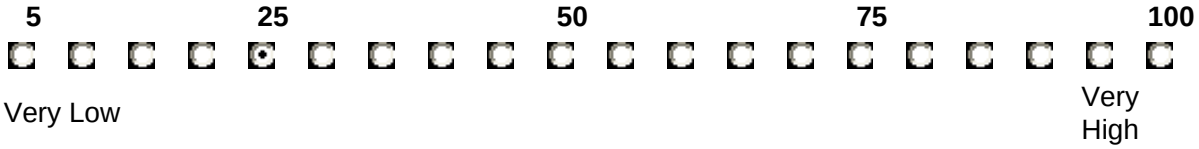
Never				Always
1	2	3	4	5

APPENDIX D TASK LOAD QUESTIONNAIRE

Instructions: Select by clicking the dot under the number on each scale that represents the magnitude of each factor in the task you just performed

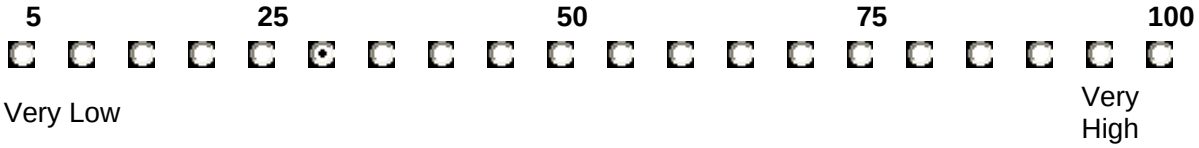
Mental Demand

How much mental perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)?



Physical Demand

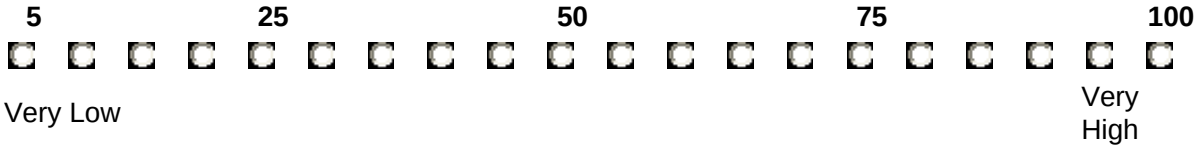
How much physical activity was required (e.g., turning, controlling, activating, holding a position, etc.)?



Temporal Demand

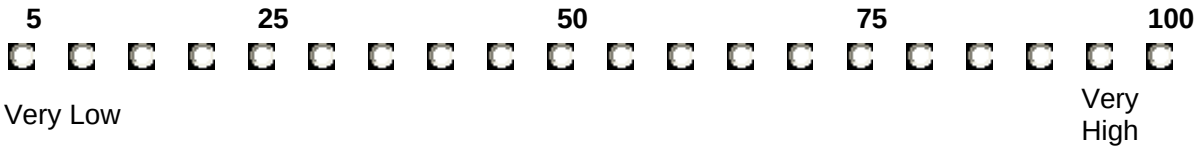
How much time pressure did you feel due to the rate of the pace at which the task or task elements occurred?

Performace
How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?



Effort
How hard did you have to work (mentally and physically) to accomplish your level of performance?

Frustration
How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed, and complacent did you feel during the task?



APPENDIX E COMMENTARY TRANSCRIPTION

Young Individuals (25 to 35 years old)

“Contenido aburrido, me gustaría mas imágenes, no me gusta la instructora

“Utilización de las herramientas correctas para desarrollar”

“Me gustaría mas interacción sin quitar todo lo que esta presente ahora, rutinario y la información fue útil”

“Interesante el reto de tener que recordar el contenido”

“No me gustó tener una dinámica unidireccional, me gustaría ver mas movimiento en el video, más ilustraciones y que el video sea más grande”

“No me gusto no poder ajustar la velocidad del guía se volvió interminable y frustrante”

“El video fue aburrido, me gusto que hubiera suficiente información para leer. El banner fue lo más útil”

“Los efectos que tenia el banner de flashear recapturaba mi atención cuando se exponía algo nuevo”

“Una investigación al día”

“Me gustaría que se hicieran más pausas para poder reflexionar en lo que el instructor acaba de decir”

“La dinámica es muy interesante… pero cuatro veces aburre”

“Aburrido. Me gusto el verde y el enfoque de rostro”

“Prefiero el instructor. Me gustaría mas colores”

“No pude establecer un método para recordar muchos números”

“El curso fue retante y creativo pero en gran parte fue aburrido y muy repetitivo”

“Me frustro el video pequeño. Prefiero en instructor”

“No me gusta el video pequeño”

Aging Individuals (55 to 65 years old)

“Buena ilustración, fácil de seguir”

“Había mucha información visual y los instructores”

“Prefiero el tamaño de la letra mas grande así como el tamaño del video y la presentación de PowerPoint”

“El curso es interesante, estuvo bien explicado y los visuales estaban perfectos”

“Las letras pasaban muy rápido”

“Prefiero la instructora”

“Placentero, útil, aprendí mucho. Las imágenes y lo escrito estaba bien explicado”

“Prefiero la instructora”

“Considero el curso y las actividades que se realizaron importantes y respetables”

“El banner la verdad puede ser eliminado”

“El contenido fue preciso y bien explicado, directo, fue directo al grano y poder verlo varias veces asegura que se pueda lograr aprender mejor el contenido”

“La presentación pasaba muy rápido pero en general la experiencia fue buena”

“Ni siquiera leí el banner, no tuve chance. El tamaño de la letra siempre puede ser más grande. La velocidad del instructor siempre puede ser mas pausada”

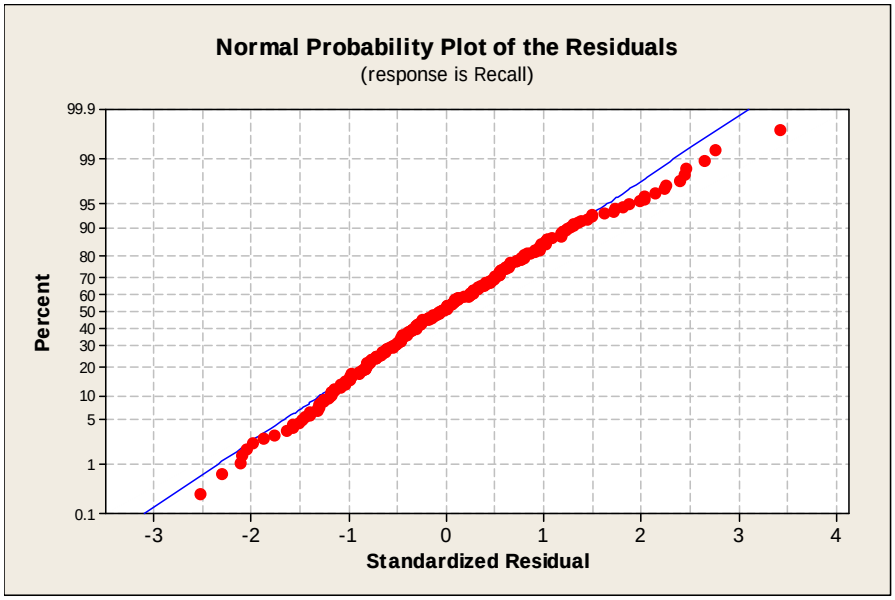
“Prefiero el instructora. Fue muy retante recordar el contenido y el fondo donde se veía el pizarrón me distraía por completo”

“Fue muy educativo. Los colores estaban bien pero era muy difícil recordar el contenido”

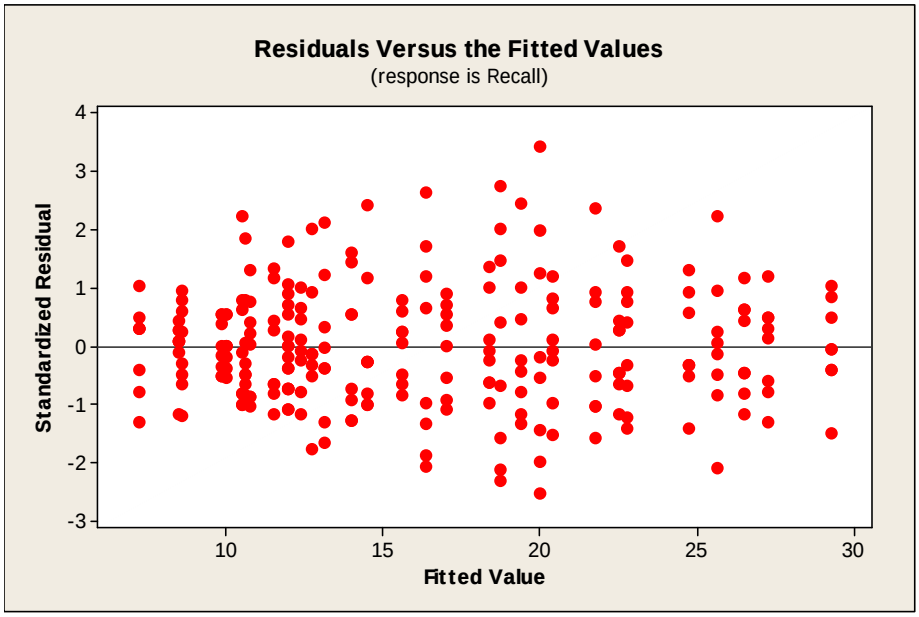
APPENDIX F ANOVA ASSUMPTIONS

Recall Variable

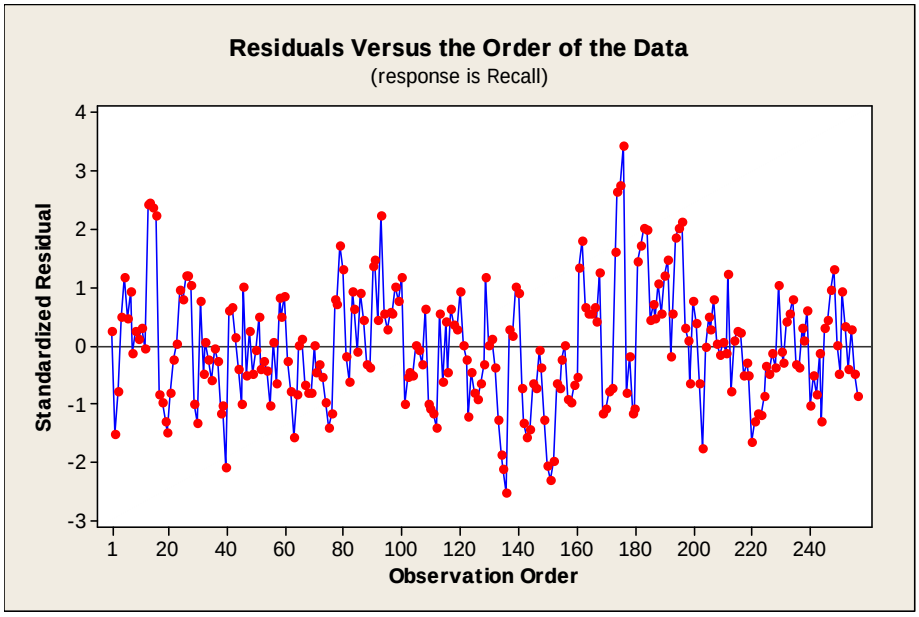
When residuals tend follow a straight line such as the displayed below it means they follow a normal distribution. This finding suggests that the assumption for normal distributed residuals is satisfactory.



The plots below displays the residuals versus the fitted values. This plot indicates no suspicious signs to invalidate the homogeneity assumption.

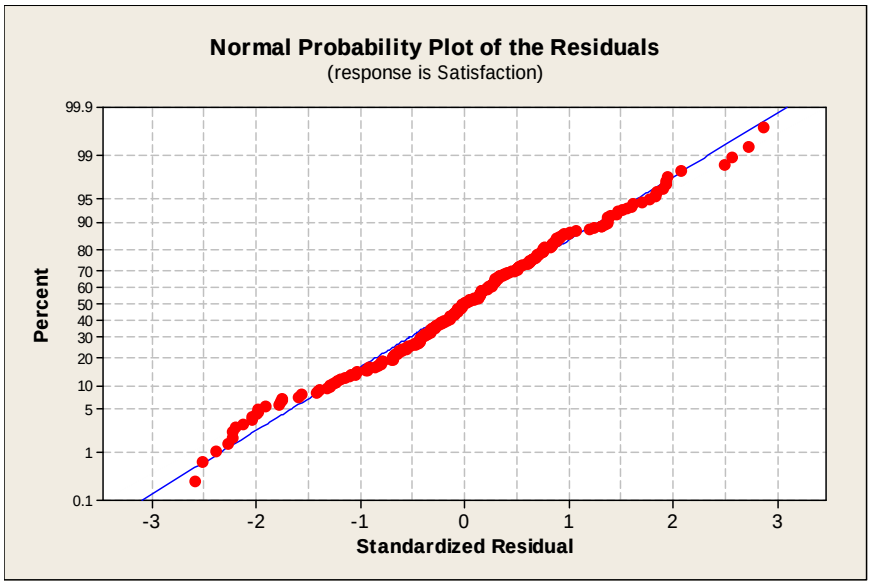


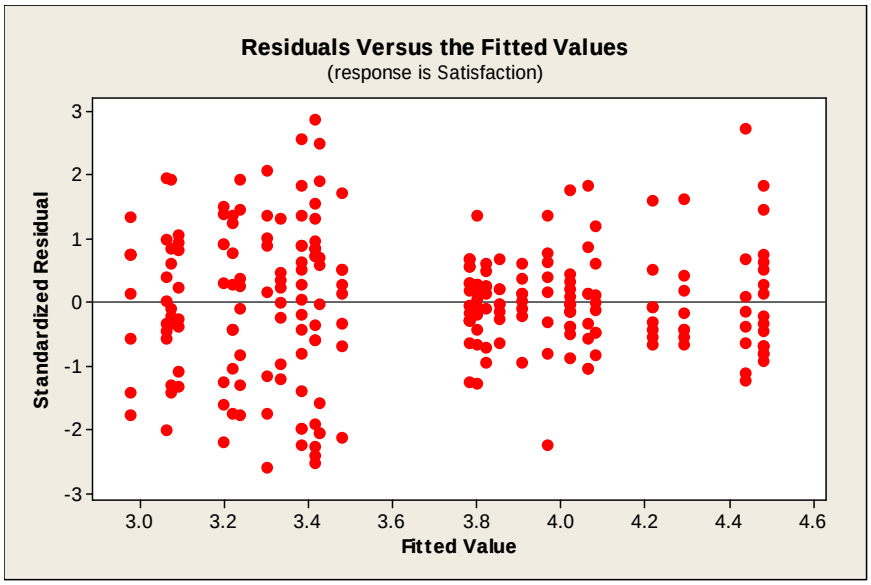
In the residual versus the order of the data plot it is possible to observe that the residuals do not present any specific tendency or pattern from which independency assumption can be satisfactorily ensured.



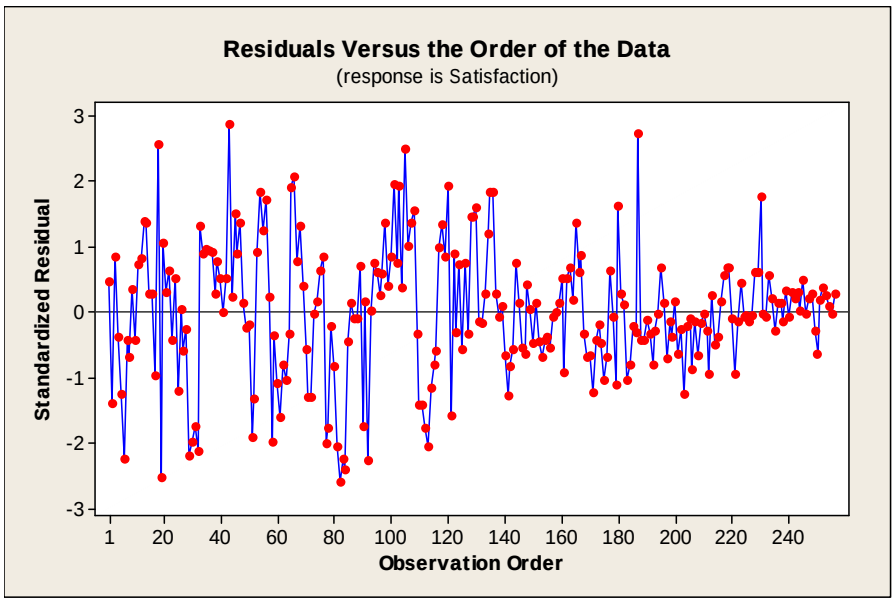
Satisfaction Variable

The aligned dots in the below Normal Probability Plot indicate that the assumption of normally distributed residuals is satisfactory. Also the Residual vs. the Fitted Values appears to be satisfactory.



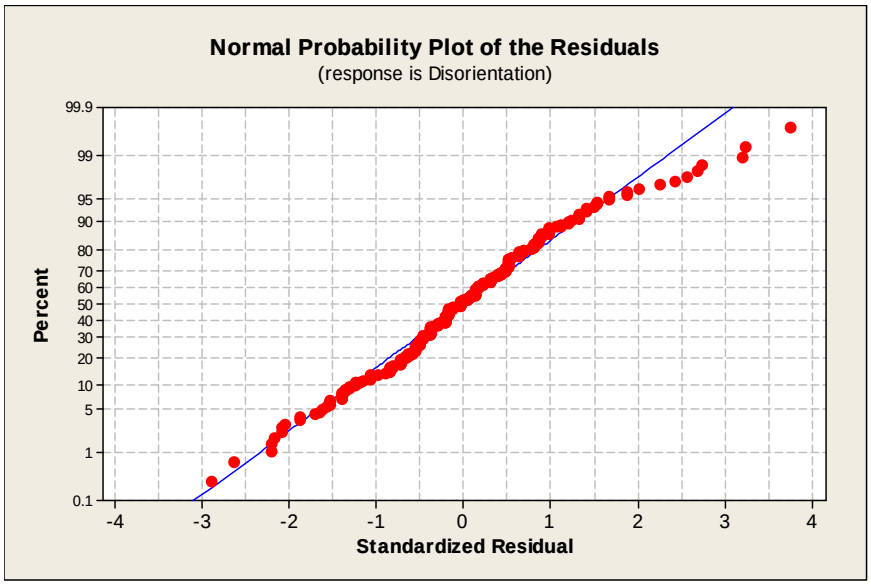


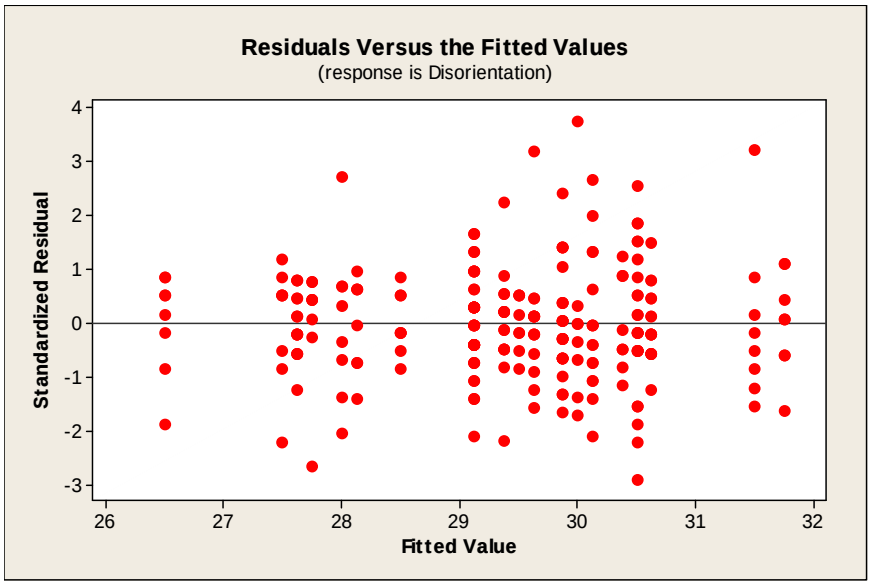
In the following plot of Residual vs. the Order of the Data of the satisfaction response there appears to be a light declining tendency at the end of the plot. This may have been triggered by the number of repetitions participants were required to view during experimental task. Overall the levels of satisfaction from the first module viewed were high and for some young individuals moderately high to moderately low while repetitions increased satisfaction varied in some cases decreasing to moderately low explaining the changes in the plot.



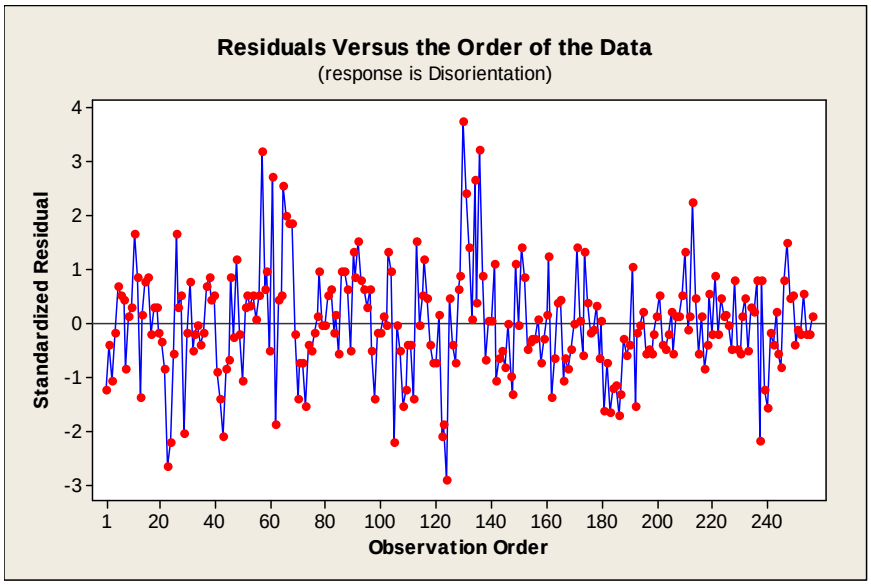
Disorientation Variable

The following normal probability plot of the residuals and Residuals versus the Fitted Values appear satisfactory eliminating any reason to suspect problems with the validity of our conclusions.



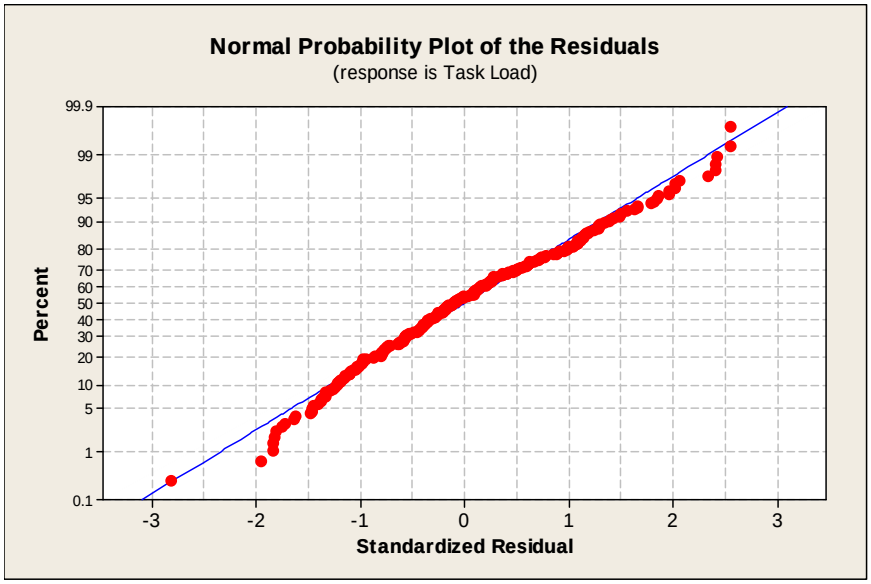


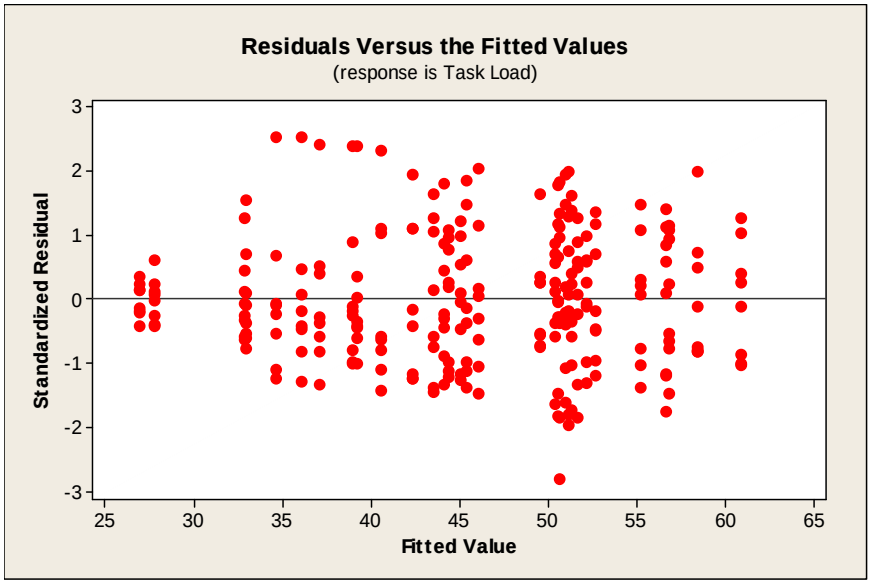
The disorientation plot for the Residuals versus the Order of the Data presented below reveals data that does not seem to follow a certain tendency or pattern that ma affect validity assumptions.



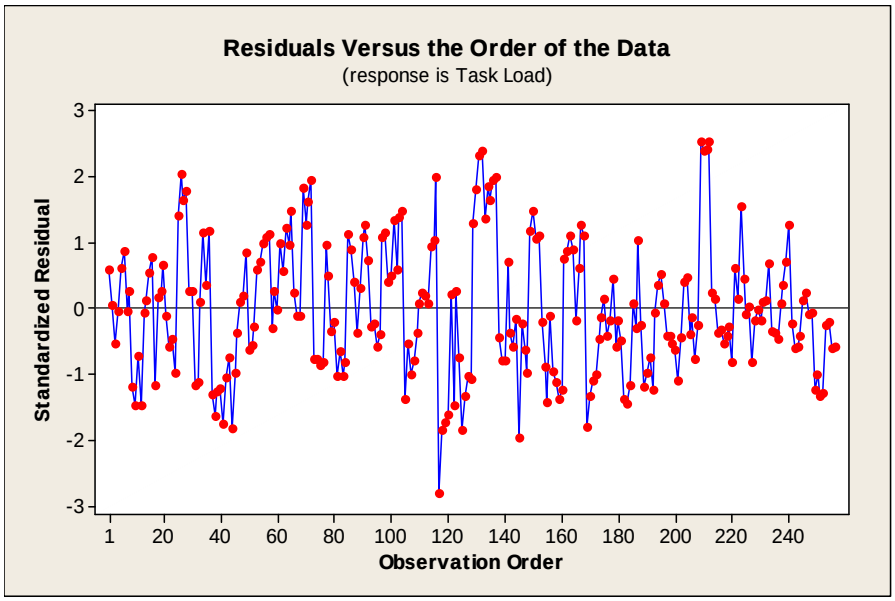
Task Load Variable

The normal probability plot of the residuals and the residuals versus the fitted values plot in the below cases does not reveal anything particularly troublesome.



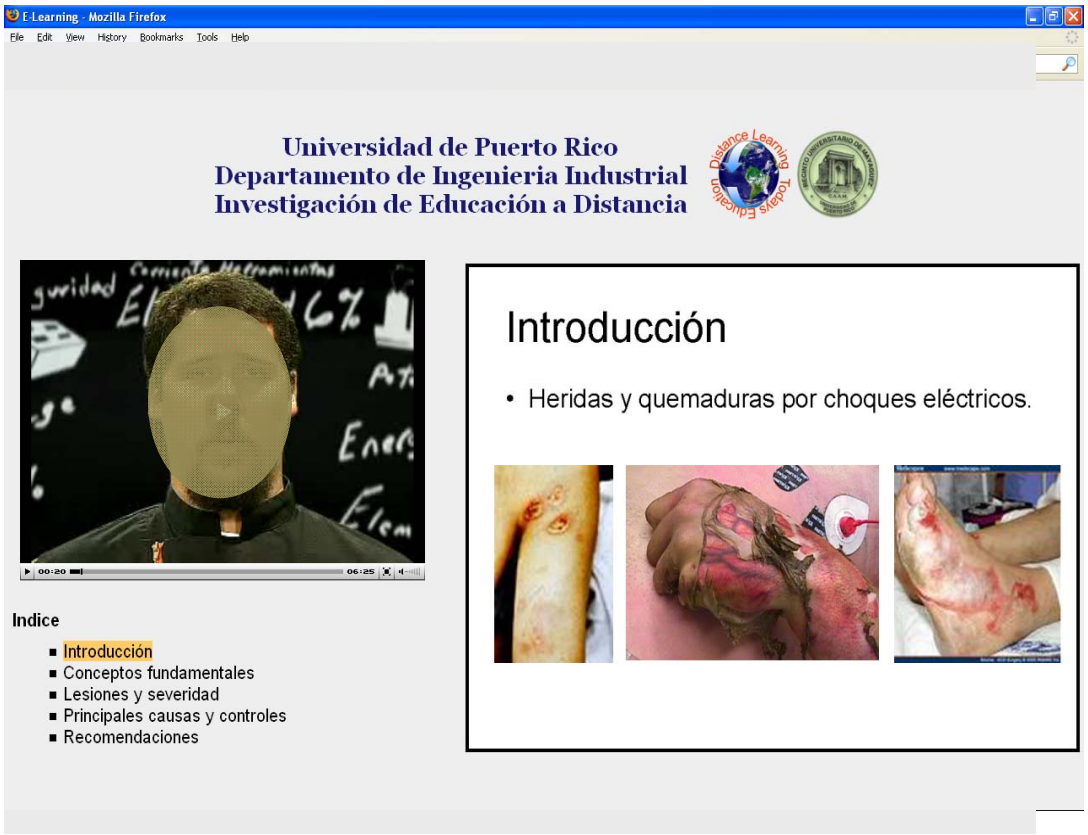


In the residual versus the order of the data plot it is possible to observe that the residuals do not present any specific tendency or pattern from which independency assumption can be satisfactorily ensured.

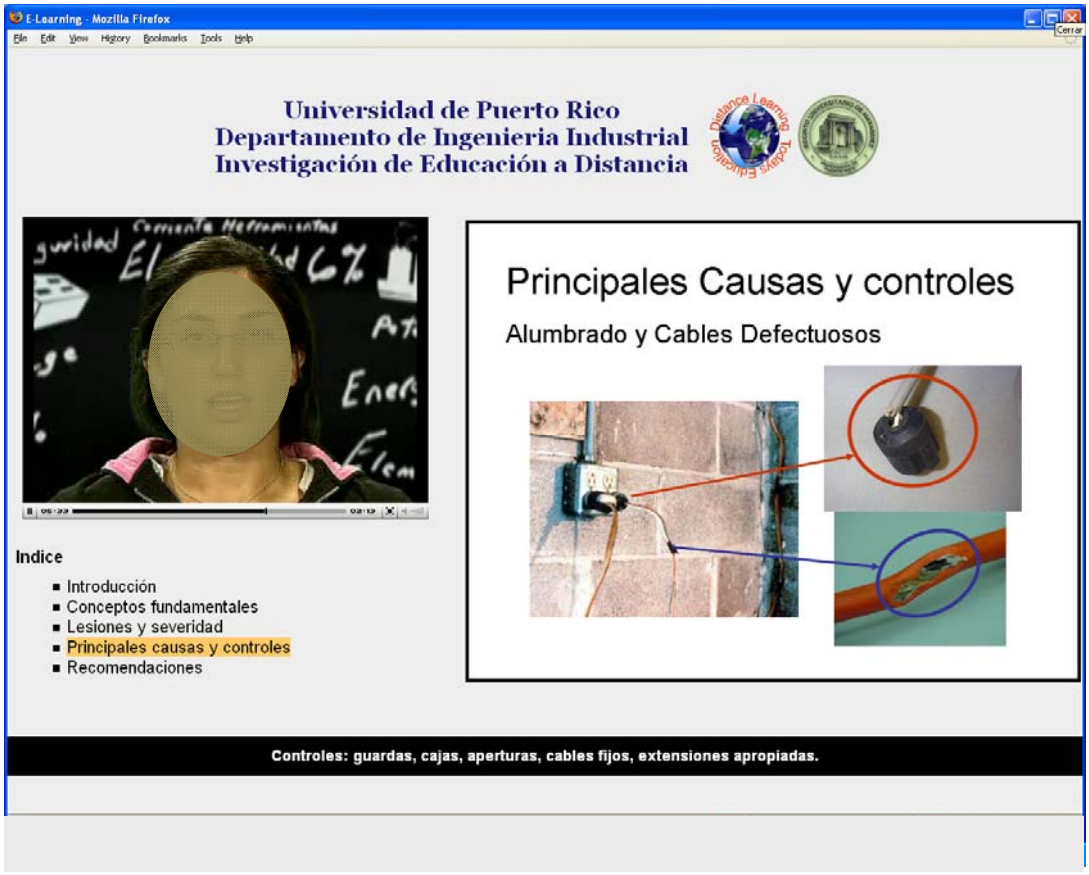


APPENDIX G MODULE SNAPSHOTS

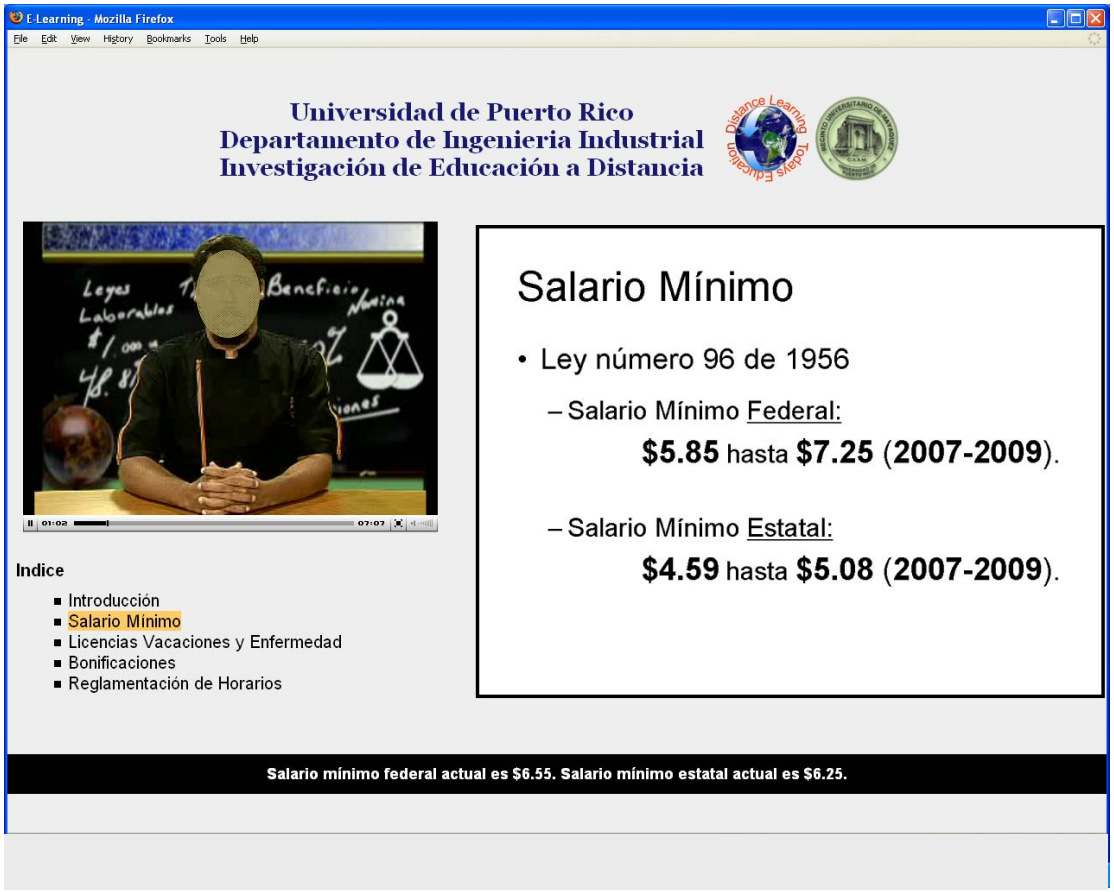
These four module snapshots are intended to provide an additional view of the difference in lesson content types. The first two images (a) and (b) correspond to a narrative type module. This lesson exposed concepts of health and safety regarding electrical safety measures. The third and fourth (c) and (d) images correspond to the numerical or computational lesson content. This last content type teaches participants how to determine and maintain track of labor compensation rights by stated by law under the Puerto Rico government. Instructors' faces are obscured in snapshots to preserve their privacy as they did not wish to be exposed in written reports.



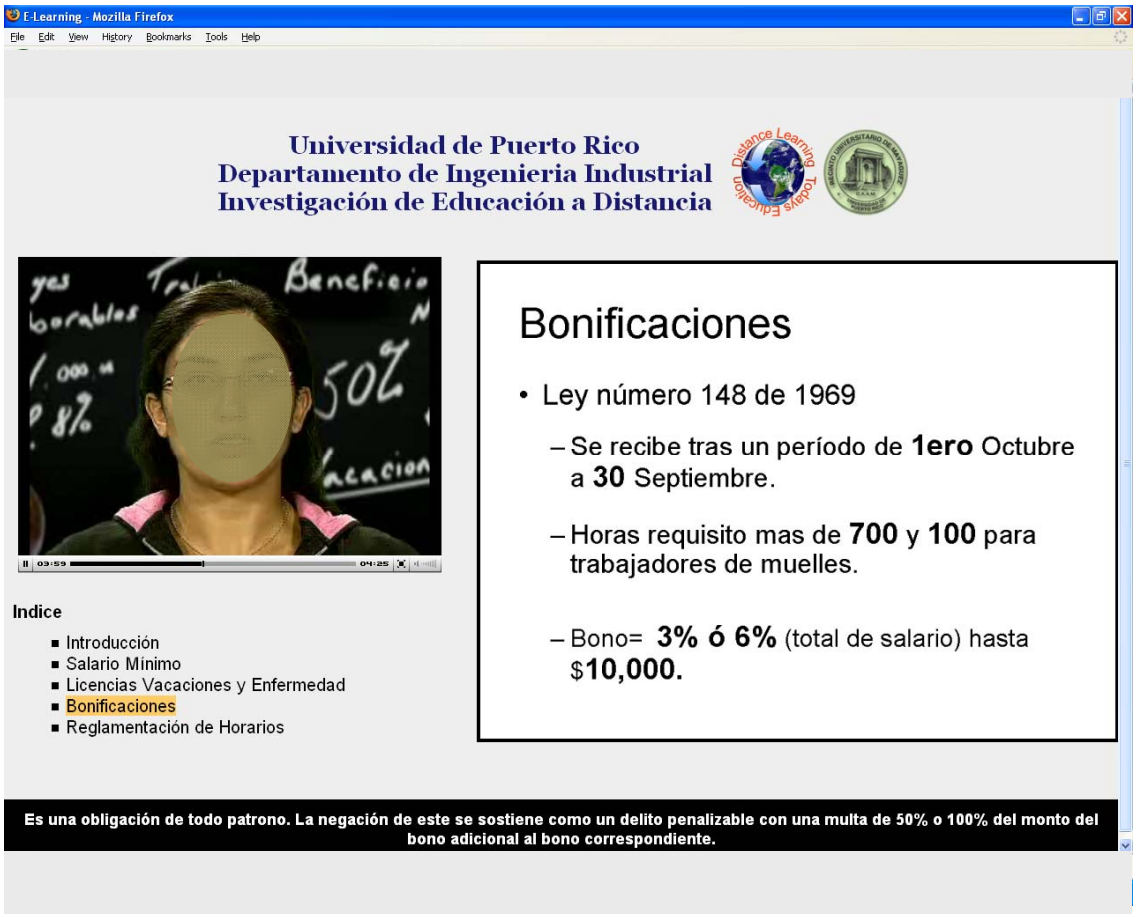
(a)


E-Learning - Mozilla Firefox
File Edit View History Bookmarks Tools Help
Cerrar
Universidad de Puerto Rico
Departamento de Ingenieria Industrial
Investigación de Educación a Distancia
Distance Learning Educación Trabajo
Indice
Introducción
Conceptos fundamentales
Lesiones y severidad
Principales causas y controles
Recomendaciones
Principales Causas y controles
Alumbrado y Cables Defectuosos
Controles: guardas, cajas, aperturas, cables fijos, extensiones apropiadas.

(b)


E-Learning - Mozilla Firefox
File Edit View History Bookmarks Tools Help
Universidad de Puerto Rico
Departamento de Ingenieria Industrial
Investigación de Educación a Distancia
Distance Learning Todays Education
Indice
Introducción
Salario Mínimo
Licencias Vacaciones y Enfermedad
Bonificaciones
Reglamentación de Horarios
Salario Mínimo
• Ley número 96 de 1956
– Salario Mínimo Federal:
$5.85 hasta $7.25 (2007-2009).
– Salario Mínimo Estatal:
$4.59 hasta $5.08 (2007-2009).
Salario mínimo federal actual es $6.55. Salario mínimo estatal actual es $6.25.

(c)


E-Learning - Mozilla Firefox
File Edit View History Bookmarks Tools Help
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Salario Mínimo
Licencias Vacaciones y Enfermedad
Bonificaciones
Reglamentación de Horarios
Bonificaciones
Ley número 148 de 1969
Se recibe tras un período de 1ero Octubre a 30 Septiembre.
Horas requisito mas de 700 y 100 para trabajadores de muelles.
Bono= 3% ó 6% (total de salario) hasta $10,000.
Es una obligación de todo patrono. La negación de este se sostiene como un delito penalizable con una multa de 50% o 100% del monto del bono adicional al bono correspondiente.

(d)

APPENDIX H IRB APPROVAL LETTER

Universidad de Puerto Rico en Mayagüez
Decanato de Asuntos Académicos
Comité para la Protección de los Seres Humanos en la Investigación
(CPSHI/IRB)

07-08 MR 01

15 de mayo de 2008

Sra. Mericia Rivera
PO Box 9043
Mayagüez, P. R., 00681

Estimada Sra. Rivera:

Me complace informarle que el CPSHI concede la aprobación de su proyecto de investigación titulado ***Desarrollo de guías de diseño para cursos y entrenamientos en línea***, con las aclaraciones y modificaciones sometidas en su carta del 27 de abril de 2008. La aprobación se extiende desde el 16 de mayo de 2008 hasta el 16 de mayo de 2009. Le recuerdo que cualquier modificación de la participación de los sujetos humanos en su proyecto requeriría una nueva solicitud de revisión.

Le deseo éxito en su investigación y agradezco su colaboración con los trabajos de este Comité.

Atentamente,

Jorge J. Ferrer, Ph.D.
Presidente CPSHI

Cc.
Dr. Agustín Rullán, Director del Departamento de Ingeniería Industrial
Dra. Cristina Pomales, Presidente del Comité de Tesis