2010

INFLUENCE OF LEARNING STYLES, GENDER, SELF-RATED COMPUTER EXPERIENCE, AND AGE ON PREFERENCE FOR COMPUTER ASSISTED LEARNING VERSUS TRADITIONAL LEARNING

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By

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THESIS

Submitted to
Northern Michigan University
In partial fulfillment of the requirements
For the degree of

MASTER OF SCIENCE

Graduate Studies Office

2010

SIGNATURE APPROVAL FORM

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ABSTRACT

INFLUENCE OF LEARNING STYLES, GENDER, SELF-RATED COMPUTER EXPERIENCE, AND AGE ON PREFERENCE FOR COMPUTER ASSISTED LEARNING VERSUS TRADITIONAL LEARNING

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Computer assisted learning (CAL) continues to become more mainstream (O'Neil & Fisher, 2008). With the presence of CAL in schools and workplaces, learner preferences for traditional learning versus CAL and the influences responsible for those preferences need to be investigated. This study examines the potential influences that may inhibit implementation of a CAL system based on the healthcare workers' preferences for a training delivery method and assesses whether a relationship exists between preference for CAL and learning styles, as well as gender, computer experience, or age. A post CAL survey collects demographics, self-rated computer experience, and learning style as measured by the Felder-Silverman Inventory of Learning Styles. Significant relationships were found between learning style and training delivery preference as well as learning style and self-rated computer experience.

DEDICATION

To my Family and especially my sister Danielle, my husband Brian , father Jerry, and grandfather Stephen, without whose support, encouragement, beliefs, and direction, I would not have taken the journey that brought me here.

AKNOWLEDGEMENTS

The author would like to thank each member of her thesis Committee; Dr. Sheila Burns, Professor Michael Strahan, and Dr. James Suksi for all of their faith and guidance. Also, thanks to Michelle Kimball for hours of service and assistance, and many thanks to husband Brian for many hours of patience, tolerance, and support.

This thesis follows the format prescribed by the Publication Manual of the American Psychological Association and the Department of Psychology.

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CHAPTER ONE: INTRODUCTION

The use of computer assisted learning (CAL) has grown greatly over the years (Al-Othman, 2004; Bontempi, 2003; Ester, 1995; Handal, 2004) and continues to rise in popularity in the workplace (DeRouin & Fritszche, 2004; O'Neil & Fisher, 2008) and higher education (Zapalska & Brozik, 2006). Global Industry Analysts predict CAL to become a more than $52.6 billion industry during 2010 (Kopf, 2007, para.1). The introduction of the computer with the Internet as an instructional tool has been viewed by some as the most potentially promising contribution of instructional technology (Allen, 1986) and potentially revolutionary for organizational training (DeRouin & Fritszche, 2004). The embracing of this technology can be attributed in part to technology advancements (Zapalska & Brozik, 2006) and the perceived advantages associated with using CAL programs such as being a consistent and reproducible means of delivery (Lynch, Steele, & Palensky, 2001), allowing monitoring of individual or group progress (Puthawala, 2002), providing more timely access to information, allowing employees to learn at their own pace and level, providing simultaneous training in multiple locations, reducing travel time and costs for training, providing more flexibility and learner control, and immediate feedback to the learner (Bontempi 2003; Chan, 1997; DeRouin & Fritszche 2004; Park & Wentling, 2007; Zhang, Zhao, Zhou, & Nunamaker, Jr., 2004) as well as improved learning success rates and information retention. (Hudson, 2004; Petroski, 1997).

Given that a significant difference between traditional learning methods and CAL is the introduction of the computer as the instructor or instructional tool, the implementation of a CAL system in the workplace may require employees to acquire and

use a new set of skills specific to computers. In implementing such a computer-centered system, employees are being asked to change from a traditional face-to face, paper-based form of learning to a less familiar computerized one and, as noted by Albert Bolognese, "resistance is an inevitable response to any major change"(2008, Introduction section). More specifically, employees may resist such a change because of having to learn something new and experiencing fear over the unknown and over their ability to adapt (Bolognese, 2008). Employee reaction to organizational change can generate such great resistance from employees that implementation of organizational improvements can be made difficult or even impossible (Folger & Skarlicki, 1999). In order to assess the sources of and levels of resistance to implementation of a computer-centered method of training delivery, and to make a smoother and less costly transition to CAL, the factors that influence learners' preferences must be studied, and individuals who are more likely to exhibit resistance must be identified.

In 2007, Dickinson County Healthcare System (DCHS), a community healthcare provider in the northern Michigan, received a grant to purchase a software product that would allow the annual safety training and testing (referred to as the "Blitz", [S. LeBombard, personal communication, July, 2008) to be delivered online via computer. The Blitz had previously been conducted by traditional paper-and-ink format for more than 10 years (S. LeBombard, personal communication, July, 2008). Based on discussions with DCHS administrating staff, several potential advantages were seen in implementing The Blitz training in a CAL format. One of the most time-saving was based on the belief that the transfer of this training to computer, if successful, would eliminate many staff hours of manual preparatory work previously devoted to

photocopying, distributing, and collecting the training materials, as well as the time spent manually grading The Blitz paper tests and answer sheets. Schedule accommodation would also be a potential benefit. By having open access to the training and testing, employees would be able to complete all or portions of the training when their schedules would allow rather than requiring employees to stay late, report to work early, or otherwise adjust their schedules which may necessitate overtime pay. A computer-based training system would also facilitate improved tracking of the training and test results, and provide more ready access to the records (S. LeBombard, personal communication, July, 2008).

One matter of concern by management and administration in implementing the CAL Blitz was the acceptance by the staff of a CAL method of training delivery, particularly since the staff contained a known population of employees with minimal to no computer experience. However, in 2008, after a trial of the CAL method of delivery, the decision was made to move forward with implementation of the CAL-format Blitz (S. LeBombard, personal communication, July, 2008).This study will examine whether there is a method of training delivery preferred by the healthcare workers in this hospital setting, explore areas of concern regarding use of a computer for learning, and will assess whether a relationship exists between preference for CAL or traditional learning and learning styles, age, gender, or computer experience.

Formally the research hypotheses being explored in this research are:

1. Adult learners who prefer CAL will have learning style tendencies of reflective, visual, intuitive, and sequential as categorized by the Felder/Solomon Index of Learning Styles (ILS).

2. Based on age, older adult learners will favor traditional methods of training delivery.
3. More computer-experienced adult learners will favor CAL methods of training delivery.
4. Female adult learners will favor traditional methods of training delivery.

Definition of Terms

Computer Assisted Learning (CAL) – Use of computers and software applications to teach concepts or skills (Puthawala, 2002): alternative terms Computer Assisted Instruction (CAI), Computer Assisted Training (CAT): sub categories such as e-learning, distance learning, hypermedia, and mutli-media.

Healthcare Worker-An employee of a regional healthcare system. This includes hands-on patient care staff, administration, and all support staff.

Learning Style - The means by which an individual prefers to learn consisting of characteristic cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how the learner perceives, processes, and recalls information.

Purpose of the Study

A decline in classroom-based instruction is expected to continue as non-traditional training formats such as CAL become the trend for workplace learning (Buch & Bartley, 2002). To overcome barriers to CAL implementation, it is necessary to understand how use of a computer to assist in learning is perceived and received by different employees so the transition to CAL can be made the most positive and beneficial learning experience possible. The objectives of this research are twofold 1) to determine hospital healthcare workers' preferences regarding CAL or traditional paper

method of training delivery, and 2) Assess if a relationship exists between preference for CAL-training-delivery method and learning styles, age, gender, or computer experience.

Limitations/Delimitations

This research is limited by the characteristics of the sample population. The sample consisted of healthcare employees of a single healthcare system in northern Michigan currently undergoing the transition from a traditional delivery of safety training to a computer-assisted form of safety training delivery.

A sample of 270 employees (from a pool of about 700 employees) working in positions ranging from hands-on patient care to facility maintenance was obtained. Participants shared the characteristic of being a volunteer.

Given that this research involved a questionnaire, it was also limited by the capability of the participants to accurately interpret the questions. It was also dependant on the willingness of the participants to honestly and accurately answer subjective questions such as self-rating of computer experience and learning style tendencies.

CHAPTER TWO: REVIEW OF LITERATURE

In this research the perceptions of a group of workers at a healthcare facility were investigated while the organization was in the midst of transitioning from a traditional face-to-face method of safety training to a computer-assisted-learning (CAL) method. This review of literature will examine learner factors that may impede implementation of a CAL system; particular attention will be paid to learning styles relationship to CAL and the perceptions of CAL by different learners, learners attitudes towards and anxieties associated with computers and CAL, and how learning styles, age, gender, and computer experience may impact these attitudes and anxieties which result in an affinity for or aversion to computer use for learning.

Learning Styles-Background

The mind, its process of learning, and what factors influence that learning process have been the subjects of studies for decades (Bransford & Brown, 2000; Bruce,). Keefe (1979) suggests that the interactions of three factors are what influence an individual's learning: the environment, the instructor, and the student himself. Variability in these influences and interactions lead to unique learning experiences and learning requirements for different individuals. Learners vary in how they take in, process, and transform information into meaning; in other words, how they learn. (Bontempi, 2003; Buch & Bartley, 2002; Dunn, Griggs, Olson, Beasley, & Gorman, 1995; Enochs, Handley & Wollenberg, 1984; Felder & Silverman, 1988; Garcia, Schiaffino, & Amandi 2007; Gorham, 1986; Gregorc & Butler, 1984; James & Blank, 1991; Kolb, 1984). Research has also supported the idea that individuals approach learning differently and so while one method of information presentation may be highly effective for select learners no

single method will be optimal for all learners (Bojancyk, 1994; Dunn et al., 1995; Enochs, Handley, & Wollenberg, 1984; Hunt, 1979; Lynch, Steele, Palensky, Lacy, & Duffy, 2001).

An understanding of the role learning styles play in learners' perceptions of CAL requires an understanding of what a learning style is. A plethora of definitions of the term "learning style" can be found (Bojanczyk & Lamphear, 1994; Dunn, Jeffrey, Beaudry, & Klavas, 2002; Fleming, 2006; Rasmussen & Davidson-Shivers, 1998; Sadler-Smith, 1996; Reinert 1976; Ingham, 1991).

In 1937 Allport used the term "cognitive style" to describe "A person's typical or habitual mode of problem solving, thinking, perceiving, and remembering" (Riding & Cheema, 1992, p. 194). In much of the literature the terms "cognitive style" and "learning style" have been used interchangeably (Dunn, DeBello, Brennan, Krimsky, & Murrain, 1981; Handal, 2004; James & Gardner, 1995; Liu & Ginther, 1999; Riding & Cheema, 1991) or combined into one term "cognitive learning style" (Graff, Davies, & McNorton, 2004; Ross, 1998). It is held by some that "cognitive style" is used more academically or theoretically and "learning style" more practically or applicably in training and education (Liu & Ginther,1991; Riding & Cheema, 1991) It also appears that learning style is viewed not as independent from cognitive style but as a more broad spectrum construct with cognitive style as a significant consideration within a learning style (Ayersman, 1993; James & Blank 1991; Keefe, 1987; Riding & Cheema, 1991) as evidenced in The National Association of Secondary School Principals' definition; a learning style is the "Characteristic cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond

to the learning environment" (Keefe, 1987, p. 5). Kolb (1984) describes learning styles as patterned, characteristic ways in which learners perceive and process information. Gregorc (1979, chapt.9) sees them as consisting of distinctive and observable sets of behaviors that reflect an individual's mind-qualities and tell how that individual relates to the world and thus how they learn. James and Blank (1991) define the construct of learning style as "How [students] receive, process, and recall information from the outside world (p. 11)." According to Davidson (1990), "Learning styles are the unique ways where by an individual gathers and processes information and are the means by which an individual prefers to learn" (p. 36). "The way each learner begins to concentrate, process, and retain new and difficult information" according to Dunn (1990, p. 224) is their learning style. For the purposes of this paper a learning style will be regarded as the means by which an individual prefers to learn consisting of characteristic cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how the learner perceives, processes, and recalls information.

By this definition and others, the learning style is believed to be a relatively consistent and stable trait (Dunn, et al. 1981; Gregorc, 1979; Kolb, 1984; Rasmussen & Davidson-Shivers, 1998). This is in accordance with Clapp (1993) who found significant short term and long term stability of cognitive style; as well as Dunn et al., 1981) who concluded that learning style factors are relatively stable but can be overcome with motivation and interest.

Learning Style Models and Measures

Many learning style models and measurement tools have been developed (See Cassidy, 2004; DeBello, 1990; Dunn et al, 1981, Hawk, 2007) to identify more or less

preferred learning styles. Learning style practitioners focus on and describe individual styles differently (Dunn et al, 1981) and no one theory is unanimously accepted (Sein & Robey, 1991). There are a number of models (See Cassidy, 2004; DeBello, 1990; Dunn et al., 1981; Felder & Silverman, 1988; Gregorc, 1979; Hawk, 2007; Kolb, 1984;) and measurement tools (See Dunn et al., 1981; Felder & Solomon, n.d; Kolb, 1984;, Myers & McCaulley, 1985) that could be explored; Curry's Onion Model, Kolb's Experiential Learning Model, Witkin's Field-Dependence/Field Independence, Gregorc's Style Delineator, Dunn and Dunn Learning Style Model, Meyers-Briggs Type Indicator, and the Productivity Environmental Preference Survey among many others (See Cassidy, 2004; DeBello, 1990; Dunn et al, 1981; Hawk, 2007).

Since the Felder/Silverman model was used in this research, this model, along with Felder/Solomon's Index of Learning Styles (ILS) will be most closely reviewed. The other most directly related models and measurement instruments, the Myers-Briggs Type Indicator (MBTI) based on Jung's theory of psychological types (Felder & Silverman, 1988), and the Kolb Experiential Learning Model (ELM) and Learning Styles Inventory (LSI) (Kolb, 1984) will also be given some direct attention (see Cassidy, 2004; DeBello, 1990; or Hawk, 2007; for additional models, details, and instruments).

Kolb Experiential Learning Model

Development of the Experiential Learning Model is credited to Dr. David Kolb (See figure 1). In this model Kolb proposes a hypothetical four-stage learning cycle containing two prehension processes and two transformation processes (Kolb, 1984; Bush & Bartley, 2002). The prehension dimension is constituted by grasping experience via apprehension or concrete experience on one end of the bipolar scale and grasping

experience via comprehension or abstract conceptualization on the other end (Kolb, 1984). It refers to what Svinicki and Dixon (1987) describe as "the input of information either from experience or from abstractions respectively" (p.141). The transformation dimension is constituted by extension or active experimentation on one end of the bipolar scale and intention or reflective observation on the other end (Kolb, 1984). It refers to what Svinicki and Dixon describe as "the processing of information by either internally reflecting on the experience or externally acting upon the conclusions which have been drawn" (pp.141-142).

The characteristics of the four stages can be summarized as concrete experience (CE – preferring to learn by physically experiencing or feeling as opposed to thinking-are concerned with uniqueness and take an "artistic" approach as opposed to scientific and are people oriented), and reflective observation (RO – preferring to learn by watching, listening, and reflecting-and focus on the understanding and the meaning of things as opposed to what works) abstract conceptualization (AC – preferring to learn by thinking as opposed to feeling- and use logic, ideas, and concepts), and active experimentation (AE - preferring to learn by doing and participating-like to have influence on people and environment, and emphasize practical application)(Kolb, 1984; Cassidy, 2004; Susan Santo, n.d.; Hein & Bundy, 1999). These dimensions combine to create Kolb's four learning styles: the Accommodators who have CE and AE tendencies and have been known for their strength in accomplishing tasks and carrying out plans, as well as their flexibility, risk taking, intuition, and trial and error way of solving problems; the Divergers who have CE and RO tendencies and are known for imaginations, sensitivity to others feelings, listening skills, awareness of meanings and values, and enjoyment of

group activities; the Convergers who have AE and AC tendencies have been found to possess tremendous problem-solving skills, to follow detailed sequential steps, have controlled emotions, and prefer dealing with technical skills over social issues; and the Assimilators who possess AE and RO tendencies most often have well-developed thinking skills, value precision and logical soundness, and are good at organizing information and inductive reasoning (Kolb, 1984; Buch & Bartley 2002; Santo, n.d.).

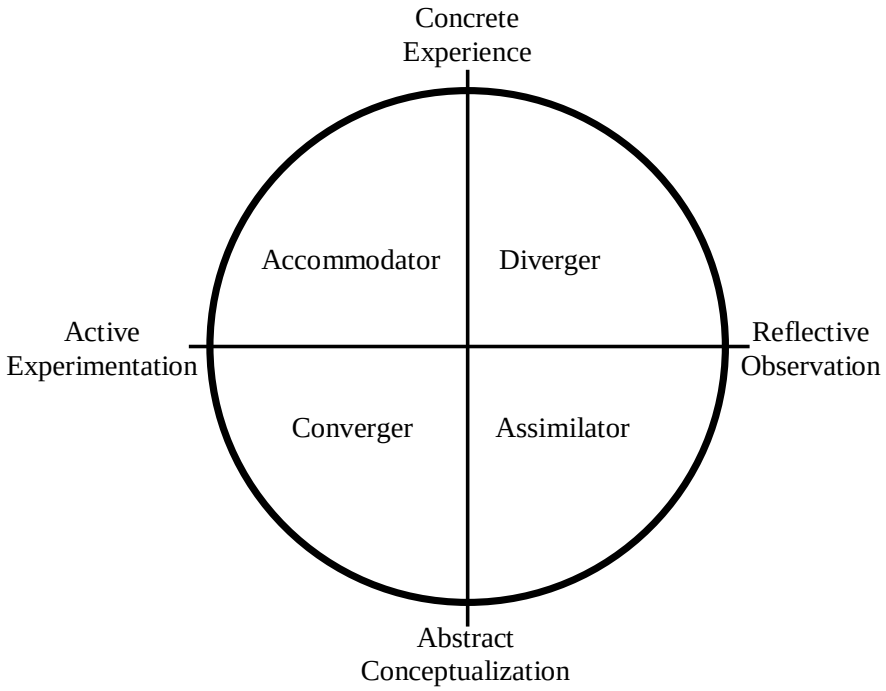

Figure 1. Kolb's Experiential Learning model. Adapted from *Experiential Learning: Experience as the Source of Learning and Development* (p. 42), by D. Kolb, 1984, Englewood Cliffs, NJ: Prentice Hall. Copyright 1984 by Prentice Hall. Adapted permission pending.

The instrument developed to categorize learning styles based on Kolb's ELM is the Learning Style Inventory (LSI). The current version is a 12-question self-report survey. For each question a participant ranks four sentence endings, each ending

corresponding to a different learning style category. The ranking-based results indicate an individual's relative inclination towards each of the four learning orientations thus enabling categorization according to the corresponding learning style (Cassidy, 2004).

Jung/Myers-Briggs Type Indicator

The Myers Briggs Type Indicator (MBTI) is a 93-forced-choice questionnaire developed by Katherine Briggs and Isabel Briggs-Myers (Tieger & Barron-Tieger, 1995). It measures how people prefer to get information, make decisions, and orient their lives. It is based on the early work of Swiss psychologist Carl Jung who in 1921 published *Psychological Types* (Tieger & Barron-Tieger, 1995). Jung proposed that there existed eight personality types based on the combined results from three bipolar personality preference scales. His book was read by Katherine Briggs who had been conducting similar work. She and her daughter Isabel Briggs-Myers, through continued work and study, expanded on Jung's work and determined there to be four preference scales and sixteen distinct types (Tieger & Barron-Tieger, 1995) (See figure 2). Wheeler (2001) points out that there are numerous ways these 16 types can be categorized including educational traits and learning styles.

Each of the 16 types is composed of two mental functions and two attitudes (Wheeler, 2001). Introversion (I) and Extroversion (E) make up the opposing ends of one scale that represents an individual's orientation or attitude towards life (Briggs-Myers & McCaulley,1985). The EI scale represents how one interacts with the world, as well as where energy is focused (Tieger & Barron-Tieger, 1995)-either inwardly or externally. Sensing (S) and intuition (N) comprise the perceiving mental function (Wheeler, 2001) representing the kinds of information an individual naturally notices (Tieger & Barron-

Tieger, 1995)-so what is perceived for processing (Briggs-Myers & McCaulley,1985). Thinking (T) and feeling (F) designate the judging mental function dealing with how inputs from the perceiving function are processed (Wheeler, 2001). Judging (J) and perceiving (P) denote the attitude toward the two mental functions (Wheeler, 2001); in other words, the interaction of the perceiving (input) mental function with the judging (processing/decision making) mental function (Wheeler, 2001; Tieger & Barron-Tieger, 1995).

ISTJ	ISFJ	INFJ	INTJ
ISTP	ISFP	INFP	INTP
ESTP	ESFP	ENFP	ENTP
ESTJ	ESFJ	ENFJ	ENTJ

Figure 2. MBTI Personality Types. Adapted from *Manual: A guide to the development and use of the Myers-Briggs Type Indicator* (p. 18), by I. B. Myers & M. H. McCaulley, 1985, Palo Alto, CA: Consulting Psychologists Press. Copyright 1985 by Consulting Psychologists Press. Adapted permission pending.

Looking at the characteristics typical of individuals with a tendency toward one end of each scale, Briggs-Myers and McCaulley (1985) propose that those with an inclination toward the extraversion end of the EI scale, called Extraverts, focus on the external world. They are quite outgoing and personable and are drawn to act on the outside environment. They are drawn to outside objects and people, while those who show preference for the introvert dimension tend to focus on introspection and be more contemplative in nature. Introverts are primarily interested in the inner world of concepts and ideas (Briggs-Myers & McCaulley, 1985).

Sensors, on the sensing end of the scale, tend to get input directly from their senses or observation and possess factual and observant characteristics (Wheeler, 2001).

They tend to focus on the immediate experience (Briggs-Myers & McCaulley, 1985) while those at the opposite end of the significance scale, called Intuitors, tend to gather information indirectly through possible meanings and relationships (Briggs-Myers & McCaulley, 1985, Wheeler, 2001), and have insightful and creative characteristics. "Jung characterized intuition as perception by way of the unconscious" (Briggs-Myers & McCaulley, 1985, p. 12). Thinkers are found on the thinking end of the TF scale and tend to possess logical, rational natures and make logical connections to link ideas and experiences while Feelers on the other end of the TF scale tend to have more compassionate and idealistic natures, making decisions based on values more than logic (Wheeler, 2001).

The final scale judging and perceiving is depicted by Briggs-Myers and McCaulley (1985), as serving two functions; describing one's behavior toward the outside world, and is an attitude. The JP scale reports on whether an individual's natural inclination is to take enough input information in to progress in a logical , step-by-step fashion to a solution as a judger (Briggs-Myers & McCaulley, 1985; Wheeler, 2001) or if one prefers to gather as much input information as possible and suspend judgment until it becomes absolutely necessary to come to a decision or solution, as a perceiver (Briggs-Myers & McCaulley, 1985; Wheeler, 2001). Judgers tend to be decisive, while Perceivers are inclined to be more questioning and remain open minded (Briggs-Myers & McCaulley, 1985; Wheeler, 2001).

Felder/Silverman Learning Style Model

The Felder/Silverman learning style model (FSLSM) began in 1987 as a cooperative effort to combine "Dr. Silverman's expertise in educational psychology"

(Felder & Silverman 1988; Felder, 2002) and Richard Felder's experience as an engineering educator. Their intent was to provide engineering professors insights into learning for the purpose of incorporating teaching methods that would both take into account and more closely match with students learning preferences (Felder & Silverman, 1998). Studies on the validity and reliability of the FSILS (Felder & Spurlin, 2005; Zywno, 2003) are discussed in the methodology section of this paper.

The FSLSM, according to Felder and Silverman (1998), is not original in that it draws from other learning styles models. Most notable in this regard are the FSLSM ties to the Jung-Myers-Briggs model and MBTI instrumented and Kolb's ELM (Felder & Silverman, 1998). The FSLSM categorizes learners along four dimensions. Two dimensions of the FSLSM have strong association with both of these other LSMs. The FSLSM's sensing/intuition dimension is drawn from the same dimension of the MBTI and is also closely related to the concrete experience and abstract conceptualization poles of Kolb's prehension dimension. (Felder & Silverman, 1998) The active/reflective processing dimension is a component of Kolb's ELM, as well as "closely related to the introvert/extravert of the." (See figure 3)

Felder and Silverman do not offer a definition of a learning style but provide five questions by which an individual's learning style may be assessed.

1. What type of information does the student preferentially perceive: *sensing* (external)—sights, sounds, physical sensations, or *intuitive* (internal)—possibilities, insights, hunches? (Felder & Silverman, 1988, p. 675)
2. Through which modality is sensory information most effectively perceived: *visual*---pictures, diagrams, graphs, demonstrations, or *verbal*---sounds,

written and spoken words and formulas?(Other sensory channels—touch, taste, and smell—are relatively unimportant in most educational environments and will not be considered here.) (Felder 1993 p. 1; Felder & Silverman, 1988, p. 675)

3. With which organization of information is the student most comfortable: *inductive-facts* and observations are given, underlying principles are inferred or *deduc*tive-principles are given, consequences and applications are deduced? (Felder & Silverman, 1988, p. 675)
4. How does the student prefer to process information: *actively*- through engagement in physical activity or discussion, or *reflectively*- through introspection? (Felder & Silverman, 1988, p. 675)
5. How does the student progress toward understanding: *sequentially-in* continual steps, or *glob*ally-in large jumps, holistically? (Felder & Silverman, 1988, p. 675)

The answers to each of these questions create the dimensions of the FSLSM. The current dimensions being sensing/intuitive, visual/verbal, active/reflective, and sequential/global (Felder & Silverman 1998). (It should be noted that the current FSLSM has been modified from the original version. Felder has replaced the "auditory" label in the original visual/auditory dimension with "verbal" to better allow inclusion of the written word on the same scale as visual tendencies. The inductive/deductive dimension has been removed also after Felder's speculation in the original paper that students would prefer induction was refuted and he did not want instructors "to be able to determine somehow that students prefer deductive

presentation and use that as a result to justify continuing to use the traditional but less effective lecture paradigm in their courses and curricula (Felder, 2002, p. 2)."

Figure 3. Scales of the Felder/Silverman Learning Style Model. Adapted from *Learning and Teaching Styles in Engineering Education: Author's Preface* (p. 1), by R. M. Felder, 2002. Copyright 2002 by R. M. Felder. Also adapted from "Learning and Teaching Styles in Engineering Education," by R. M. Felder, and L. K. Silverman, 1988, *Engineering Education, 78,* pp. 674-680. Copyright 1988 by American Society for Engineering Education. Adapted permission pending.

Sensing/Intuitive Scale

The first dimension of the current FSLSM, the sensing/intuitive (S/I), is based on the two ways that Carl Jung proposed individuals "tend to perceive the world" (Felder & Silverman, 1998, p. 676), which is the same as the SN perceiving mental function previously defined in the Jung, Myers, Briggs, MBTI section. Sensing individuals (sensors) naturally perceive certain types of input information directly through the senses and observation and prefer facts and data while intuitive individuals (intuitors) perceive input indirectly by speculation and imagination and prefer principals and theories. An important distinction Felder and Silverman (1988) add to their S dimension is that Intuitors have a greater comfort level with symbology than Sensors which allows Intuitors to more easily translate the written word into meaning (Felder & Silverman, 1988). This dimension also closely relates to Kolb's prehension dimension where input is accomplished through the concrete experience of using ones senses and actually feeling

the world around us or by the thinking and speculation of abstract conceptualization (Felder & Silverman, 1988). (See figure 4)

Visual/Verbal

The second dimension, the visual/verbal (V/V), refers to the modality through which learners receive information. There are actually three modalities; visual, verbal, and kinesthetic. Only visual and verbal modalities are addressed in Felder and Silverman's learning style model as they believe "visual and [verbal] learning both have to do with the component of the learning process in which information is perceived, while kinesthetic learning involves both information perception (touching, tasting, smelling) and information processing (moving, relating, doing something active while learning, and that the perception-related aspects of kinesthetic learning are at best marginally relevant … and that the processing components of the kinesthetic modality are included in the active/reflective learning style category" (Felder & Silverman, 1988, p.676).

Looking at learners with visual input preferences, there is one primary characteristic. Visual learners get and retain more information from visual images such as pictures, flow charts, films, demonstrations, diagrams, or graphs (Felder & Soloman, 1993, Felder & Silverman, 1988; Felder, 1993). They are highly likely to forget something that is only said to them or discussed with them. Without visual input, they are not likely to hold on to the information (Felder & Soloman, 1993; Felder & Silverman, 1988; Felder, 1993).

Verbal learners are the polar opposite of visual learners. They get a great deal out of discussion and learn effectively by explaining things to others. They would rather

receive a verbal explanation than a visual demonstration (Felder & Soloman, 1993; Felder & Silverman, 1988; Felder, 1993).

Active/Reflective

The third dimension, the active/reflective (A/R), refers to how learners process the information that they have received. Felder and Silverman (1988) identify how "the active learner and the reflective learner are closely related to the extravert and introvert, respectively, of the Jung-Myers-Briggs model" (p. 678). Felder and Silverman (1988) define this dimension of the FSLSM directly from Kolb's (1984) transformation processes as "The complex mental processes by which perceived information is converted into knowledge can be conveniently grouped into two categories: active experimentation and reflective observation" (Felder & Silverman, 1988,p. 678) where active experimentation involves discussing, explaining, or working with the information in the external world and reflective observation involves introspectively examining and manipulating the information (Felder & Silverman, 1998). Felder and Silverman also emphasize that active learners do not learn much in situations that require them to be passive, preferring group work to solitary learning and possessing tendencies to be experimentalists; whereas reflective learners prefer solitary work or at most work with one additional person.

Sequential/Global

The final dimension, sequential/global (S/G), deals with how learners work toward understanding the information they have received and processed (Felder & Silverman, 1998). Sequential learners gain understanding in logical, linear steps and tend to be strong in convergent thinking and analysis (Felder & Silverman, 1988). Sequential

learners master information in a logical progressive manner by adding together "small connected chunks" (Felder, 1993, Sequential and Global Understanding para. 1). They can work with material even when their understanding of the subject is only partial or superficial and the solutions they present are generally systematic and easy to follow (Felder & Silverman, 1988; Felder, 1993). They may however have difficulty grasping the big picture (Felder, 1993). "Sequential individuals learn best when information is presented in a steady progression of complexity and difficulty" (Felder & Silverman, 1988, p. 679). Felder and Silverman (1988) have pointed out that most education courses are taught in a sequential-learner-friendly method.

Global learners however, often have difficulty in school since they learn in "fits and starts" (Felder and Silverman, 1988 p. 679) rather than in a steady and progressive manner. Global learners may struggle and even feel stupid and incapable when sequential-learner peers are easily grasping materials with which the global learner is struggling to understand (Felder & Silverman, 1988). Felder and Silverman (1988) propose that this may be partly due to the sequential presentation of material in logical and more complex steps. Global learners typically achieve understanding in holistic leaps and bounds after taking in information in seemingly disjointed bits and pieces (Felder, 1993; Felder & Silverman, 1988). They tend to be strong in divergent thinking and thus require more conceptual presentation (Felder & Silverman, 1988).

Summarizing the relative shared learner characteristics based on Felder and Soloman's ILS, the MBTI, and Kolb's LSI, one may conclude that learners categorized as sensing by Felder would also be assessed as sensing by the MBTI. They would share all similar traits including being more attune to information received as facts and data in a

concrete manner, through senses and observations as would Kolb's accommodators and divergers (though it should be pointed out that in Kolb's categorizations, information would be processed through different methods than by Sensors). Learners with ILS/MBTI results of Intuitive would share a perception preference with Kolb's convergers and Assimilators for information received more indirectly through such abstract means as speculation, imagination, or symbology.

The second ILS scale that closely relates the MBTI and the LSI, is the active/reflective scale. An individual classified as an MBTI- extrovert would be expected to share many characteristics of a learner classified as active by the ILS. These traits would include acting in the external world by testing information through experimentation or taking part in a group discussion, along with the active experimental information processing tendencies of a Kolb converger or accommodator. On the opposite end would be the ILS Reflector and the MBTI Introvert. These learners would be more likely to focus and process information internally and alone as would a diverger or Assimilator. (For more comparisons of learning style similarities and overlapping categories see Drummond & Stoddard, 1992; Dunn, 1990; Dunn, Beaudry, & Klavas, 1989; Fleming, 2006; Hawk, 2007; Kolb, 1984; Witkin, Goodenough, & Cox, 1977).

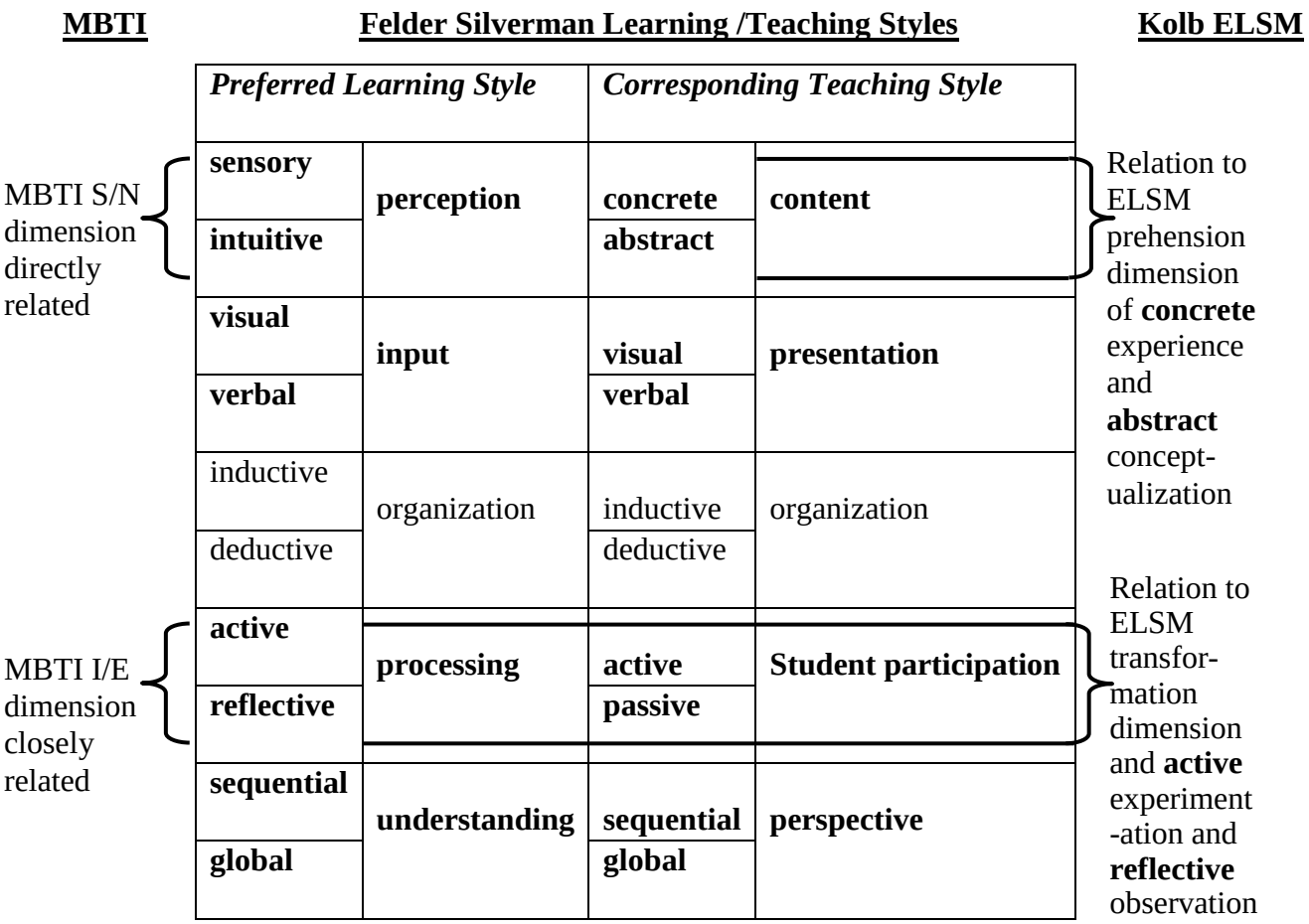

Figure 4. FSLSM-MBTI-Kolb ELSM Learning Style Dimension Relationships. Adapted from from "Learning and Teaching Styles in Engineering Education," by R. M. Felder, and L. K. Silverman, 1988, *Engineering Education, 78*, p. 675. Copyright 1988 by American Society for Engineering Education. Adapted permission pending.

Learning Styles and Teaching Style Congruency

As mentioned earlier learners have preferred methods of learning. Instructors tend to conduct their courses in ways that agree with their personal learning styles (Davidson, 1990). The impact of congruent learning and teaching methods on students' learning experience is an area of research that, as we will show below, has borne mixed findings. Results of no significant relationships between learning and teaching style congruence were reported by Keri (2002) who looked at nearly 700 students and 25

instructors for a correlation between congruent learning and teaching style and student satisfaction. Stokes (2003) similarly concluded that learning style was not a significant predictor of learning satisfaction in online education.

Learning style practitioners stress the impact learning styles have on a student's learning experience, performance success (Ault, 1986; Ayersman, 1993; Bojanczyk, 1994; Dunn, 1990; Ester, 1995; Gregorc & Butler, 1984; Kolb, 1984; Zapalska & Brozik, 2006), preference for learning activities (Schaller, Borun, Allison-Bunnell, & Chambers, 2007), motivation to learn (Hein & Bundy, 1999), attitude (Dunn, 1990), comfort (Ross & Schulz, 1999; Marwhinney & Saraswat,1991), and relationship with the instructor (Gregorc, 1979), when accommodating learners' styles in delivering academic or training materials. On the opposite side they also point out the distress, discomfort (Churchill, 2008; Gregorc, 1979), impairment or utter failure to learn (Dunn, 1990), and burnout (Gregorc, 1979) that can result from exposure to a "prolonged and chronic mismatch" (Gregorc, 1979, pg 24). Gorham (1986) also found the literature to indicate that significant impact occurred when matching or mismatching learning style and instructional technique. Riding and Wicks (1978) found performance lowered by more than 25% when a style mismatch occurred.

Matching of learning style and instruction style has been shown to reduce time on task (Boles, 1999), improve student interest, enthusiasm (Ault, 1986), and attitude (Lefkowitz, 2006), increase student motivation to learn (Hein & Budny, 1999) and productivity (Ault, 1986) and improve overall course and test scores (Dunn et al., 1995; Ester, 1995; Lefkowitz, 2006). Hoffler (2001) also found through personal practice that individualized learning experiences improved both course results and evaluations.

Learning styles and how well an individual's style matches with the instructor's becomes even more relevant when the computer becomes the instructor or instructional tool. Gregorc and Butler (1984) report "it is at the point where human beings and technology meet that friction can occur" (p. 27). Since students are no longer interacting with a flexible human being, but a statically programmed machine, learners may not be able to adjust to the "invisible demands" (Gregorc & Butler, p. 27) placed on them by the rigidity of the computer. Buch and Bartley (2002) warn that "learning environments that are not consistent with an individual's style are more likely to be rejected or resisted by the individual. This may be especially true for today's high-technology delivery methods" (p. 6). Particularly since learning style is considered to be one of the more important factors that influence forms of CAL (Wang, Wang, Wang, and Huang, 2006).

Not all learners respond to the use of the computer in the same way (Billings, 1992; Park & Wentling, 2007). Some individuals feel anxious about using a computer, others are quite comfortable with it (Ames, 2003; Bonzelios, 1997; Mawhinney & Saraswat, 1991; Ross & Lukow, 2004); certain individuals may find the technology motivating (Leuthold. 1999) others find it alienating (Ross, 1997) or less personal (Kroeze, Oenema, Campbell, & Brug, 2008), rigid and inflexible (Gregorc & Butler, 1984; Steele Palensky, Lynch, Lacy, Duffy, 2002). Therefore computer-based instruction may not be appropriate for all learners (Ames, 2003; Ross & Schultz, 1999). Indeed Gregorc and Butler (1984) caution that "Not all students are able to, or even want to, receive their education exclusively by computer" (p. 29).

Learning Styles and Relationships to Computers and CAL

An individual's learning style is considered potentially useful in identifying learners who may or may not favor CAL (Brudenell & Carp, 1990) or perform as successfully (O'Neil & Fisher, 2008). Learning preferences have been found to be a significant indicator of learners' reactions to online education (Al-Othman, 2004), predictor of successful distance or online computer assisted learning (Christensen, 1999; Wang, 2006) as well as being associated with an affinity for, or possessing anxiety about the use of computers (Ames, 2003). It has, therefore, been recognized that despite the benefits of CAL, if learner characteristics, including learning styles,are not considered when CAL systems are designed frequent difficulties may occur (Graff, Davies, & McNorton, 2004).

Research will be reviewed below exploring the conflicting findings regarding learning styles and perceptions of computers and CAL. Some studies have found little or no relationship between learning styles and perception of computers and computer use for CAL (Bush, 2006; Keller & Cernerud, 2002; Oh and Lim, 2005; Ross & Lukow, 2004; Wang, 2001) others have reported relationship trends and statistically significant relationships between learning style and perceptions of computer use and CAL (Leuthold, 1999; Sabry & Baldwin, 2003; Workman (2003).

Oh and Lim (2005) administered Witkin's Group Embedded Figures Test (GEFT) and a self-developed student-attitude-toward-online-instruction survey to students at the University of Tennessee to determine if cognitive styles, learning behaviors, and attitudes toward online education were correlated. They found that cognitive style was not among

the factors that significantly related to attitude or preference for instructional delivery mode.

Lynch, Steele, Palensky, Lacy, and Duffy (2002) performed two studies looking at learning styles and CAL. One involved 150 medical students who were asked to take the Rezler Learning Preferences Inventory (RLPI) and the Computer Attitude Survey (CAS) which measures reaction to, comfort with, and attitude towards computers, and the learning. They found that overall the students preferred a traditional method of delivery even though CAL was rated "highly effective" and that this preference was not a bias due to learning style. Interviews with 31 of the students revealed a recurring concern for a lack of student-and-teacher interaction. This was noted as possibly contributing to the preferences.

Lynch et al.'s 2001 study recruited180 medical students to whom they administered the CAS and the RLPI. They found no significant relationship between learning [style] preferences, attitude toward the computer, or test performance. They did note that this group displayed high mean scores on the concrete scale, which is consistent with other medical and allied health studies, and a trait found by Enochos, Handley, and Wollenberg (1985) to have greater success with CAL.

Ross and Lukow (2004) similarly found no significant relationship between learning style and perception of computers in a learning curriculum but also noted a very high number of accommodators (who also share the trait of Concrete experience-coupled with active experimentation) and the lowest number represented convergers.

Such results which do not show a relationship between learning style and perception of computers and CAL are not, however, consistent with other's findings that

have indicated correlations between learning styles and different perceptions of computers and computer usage for learning, as well as significant relationships with specific learning style characteristics (McNaulty, Espitiru, & Halsey, 2002; Sabry & Baldwin, 2003).

Learning Styles and Human-Computer Interaction

Learning style has been shown to have a significant relationship to human computer interaction and usage for learning (Fitzgerald & Semrau, 1998; Liu & Reed, 1994; Ross & Schulz, 1999; Workman, 2003), performance (Ross & Schulz, 2004), perceived effectiveness (Steele, Palensky, Lynch, Lacy & Duffy, 2002; Workman, 2003), and learner satisfaction (Al-Othman, 2004). Looking at field dependant (FD or global as defined by Witkin, Moore, Goodenough, & Cox, 1977) and field independent (FI) learners in a hypermedia environment Handal and Herrington (2004) concluded that existing literature suggests a hypermedia instructional environment is more likely to favor FI learners. This is a sentiment shared by Paolucci and Rocco (2009), who investigated learning style and structure of hypermedia and concluded that the FI learners may perform better in such an environment because of the lessened structure.

In other CAL applications, Sabry and Baldwin (2003) also explored differences in human-computer interaction and the actual importance of use and perceived importance of use for interactions in an online course. In their research the that global learners showed a significantly higher overall computer application usage than sequential learners. This is in contrast to Leuthold (1999) who found that sequential learners used CAL more frequently and random learners had more trouble with navigation and web use.

FI learners were also found to prefer software features different from FD learners (Liu & Reed, 1994). Sixty three college students were asked, in an English language enhancement program, to respond to the questions of the GEFT to establish Field Dependant (FD) Field Mixed (FM) and Field Independent (FI) learning style as defined by Witkin, et al. (1977). They reported no significant relationship between learning style and success rate but found behaviorally consistent and statistically significant relationships between learning style and multiple facets of human-computer interaction for learning. FI learners listened to audio experts twice as much as FD learners, and FD learners used more global strategies, spending twice as much time online and accessing the software twice as much as FI learners to watch learning videos. This FD behavior was considered consistent with global characteristics since the videos gave more of a big-picture view. These results parallel Fitzgerald and Semrau (1998) who also reported FI learners listened to commentary nearly twice as long as FD learners, FD learners employed more global strategies, and spent nearly twice as long online working on problem solving as FI learners.

Reed, Oughton, Ayersman, Erin Jr., and Cissler (2000) also investigated the differences in computer usage between FI and FD learners and found that FD learners navigated significantly more in both non-linear and linear steps than FIs. FIs also spent significantly more time on task, as do concrete learners according to Bostrom, Olfman, Sein (1990).

Using the Gregorc Style Delineator, Ross and Schultz (1999) recruited 70 undergraduate volunteers in a CAL cardio pulmonary resuscitation course to explore learning styles impact on human-computer interaction. They concluded that "learning

styles significantly affected learning outcomes" (p.1) and that CAL may not be suitable for all learners. In their study, a significant correlation was reported between learning style and achievement along with non-significant trends in learning style and human-computer interactions. They found that AR learners viewed less video on the computer, spent less time, and had fewer interactions with the computer. This would support the assertion that "CR and AR individuals may become flustered and agitated when problems arise with the [computer] medium" (Ross & Schultz, p.9).

Al-Othman (2004) found that both gender and learning style were significantly correlated with learners' reactions to online learning. He found that CE learners did not like online threaded discussions but liked active assignment exercises, AC learners did not like online active assignment exercises, AR liked threaded discussions but not chat rooms, and while most learners did not care for the chat rooms AE learners "hated" them.

McNaulty et al. (2002) concluded that, in a CAL context, medical students' use of computers is related to MBTI categorized types. The researchers took an interest in learners' patterns of computer usage after finding a CAL study that revealed inequities in the use of computer resources among individual medical students.

In one of their own studies, McNaulty et al. (2002) used the MBTI to classify 236 students in a Human Body course and gathered data on the students' frequency and length of time using the computer resources. The researchers found that the most represented categories (Feeling and Judging) among their students were also those learners "who tended to use computer technology more sparingly" (p.11). Regression analysis confirmed this trend which was observed to be in general agreement with Smith, Munday, and Windham (2002) and Chambers, Hardy, Smith, and Siety (2003)who

reported that teachers with thinking or intuitive propensities tended to use technology more than their respective feeling and sensing counterparts. Intuitives have also been shown to have a greater acceptance of technology (Chambers et al.) and higher reported Internet use (Graff, Davies, & McNorton, 2004) than sensors. This would stand to reason as sensors, along with reflectors, were found to be less confident in using a computer for a math class (Ali & Kor, 2006).

Classifying 57 elementary teachers using the MBTI, Knupfer (1989) also reported significant relationships between the teachers' MBTI classifications and the amount of district-provided training teachers had taken and feelings of adequacy about the training. Knupfer concluded that Intuitive teachers needed more help getting started and required more training before they were comfortable with computers than did their sensing counterparts. Her findings were contrary to Smith, et al. (2002), and McNaulty et al. (2002).

This literature has shown that learning styles relate to how individual learners interact with the computer. Time on task, level of comfort with the machine, features selected, navigation, and frequency of use were found to vary between the different learning style with a variety of learning style models represented. Human/computer interactions varied but no definitive patterns of variance were discerned.

Learning Styles and Preference for CAL versus Traditional Delivery

CAL environments require greater use of abstract conceptualization and reflective observation (Argon, 2002), strong analytic capabilities (Oh & Lim, 2005), high self direction (Oh & Lim; O'Neil and Fisher, 2008), high responsibility, self motivation

(O'Neil and Fisher, 2008), independent (Oh & Lim; O'Neil and Fisher) active learning (O'Neil and Fisher), and a more abstract approach (Diaz & Cartnal, 1999)

These and other individual learning style traits have been found to correlate in contradicting fashion with an affinity for or aversion to (Ames, 2003), confidence-or lack of confidence in (Ames, 2003), and comfort or anxiety with the use of a computer for CAL (Ames, 2003; Billings, 1999) in studies comparing preferences and performance between traditional face-to- face and CAL delivery formats as discussed below. Zapalska and Brazik (2006) concluded that auditory learners may not prefer online learning. They arrived at this after looking at the breakdown of LS representation in their sample of two online courses during two different semesters. Only two students in their sample of twenty five online students possessed auditory tendencies as their primary learning style.

Sensory/feeling individuals who are looking for meaning and relationships are considered least likely to be comfortable with computers for learning (Smith, Munday, & Windham, 1995). Feeling individuals have displayed poorer attitudes toward CAL (Alberty, 1987) and have been found to be less comfortable with computers (Marwhinney & Saraswat, 1991) than their Thinking counterparts. Extraverts too reported discomfort with computers at a nearly significant level for technophobia and a significantly negative correlation with computer thoughts and attitudes (Korukonda, 2006). Conversely, Intuitive/Thinking types who are more creative, analytical, logical, and imaginative are more receptive to computers for learning than Sensors who are practical, realistic, and sociable (Smith, Munday, & Windham, 1995). Although in 2000 Ahn found Sensing individuals to have the highest satisfaction with CAL in distance education and Othman

(2004) found Intuitors to be least satisfied (only 58% satisfied) with an online course that had a satisfaction rating of 81% from the combined learning style groups.

Learners with high sequential tendencies have been found to prefer CAL over traditional delivery methods (Ames, 2003, Leuthold, 1999). A highly sequential learning style positively correlated with confidence in using a computer for CAL (Ames, 2003) along with frequency of use of the computer in the classroom. It increased sequential learner motivation and was perceived by the sequential learners to strongly improve instruction interaction (Leuthold, 1999). A clearly negative relationship was established for highly random learners (Ames, 2003; Leuthold, 1999) who were disfavorably inclined toward CAL (Ames), have been found to have difficulty adapting to the computer Ross (1997), and have shown indications of having an aversion tendency to learning from a computer (Ross & Schultz, 1999)

Abstract learners with sequential processing, however, showed confidence with using a computer for CAL and favored such a delivery format. This contradicts Sabry and Baldwin (2003) who found that learners with strong sequential tendencies perceived learner-to-learner interactions to be more important while global learners preferred working with the computer. It is somewhat supported by Argon (2002) who compared learning style traits between students who chose to enroll in a face to face course with those who chose a CAL online class and found CAL students to be significantly more reflective and score high in preference for abstract conceptualization. Argon's results also indicated that traditional students were significantly more active experimentation and had a greater use of support techniques.

Level of dependence or independence consistently relate to preference for or against CAL (Abouserie, 1992; Chan, 1997; Diaz & Cartnal, 1999). Comparing students who selected online-delivery format with students who selected traditional classroom format Diaz & Cartnal (1999) administered the Grasha-Reichmann Student Learning Style Scale and found online students had significantly higher independent scores, as is characteristic of field independent individuals (Witkin, Moore, Oltman, Goodenough, Friedman, Owen, & Raskin, 1977), and significantly lower dependant and collaborative scores. This corresponds to Witkin, Moore, Oltman, Goodenough, Friedman, Owen, and Raskin's (1977) assessment that among FI/FD's important differences in personal characteristics include FD people being more sensitive to social environment and more collaborative in nature while FI are more solitary, separate, and independent and supports Oh and Lim's (2005) report that CAL entails independent activities and requires high self direction so is regarded as better for FI learners.

Diaz & Cartnal (1999), assessed their student sample to be "strongly independent" (pg. 26) preferring solitary-less socially interactive learning. Diaz & Cartnal further found that traditional learners were more dependant and preferred high social interaction for discussion and activities as well as structure, guidance, and approval from the instructor. This conflicts with Abouserie, Moss, and Barasi (1992) who saw no significant difference between FI and FD learners for overall preference of delivery format but did find an overall positive response to CAL and a significant difference between FD and FI on what they termed "the crucial" (p. 156) subscale. This subscale was reaction to the statement "Would you be prepared to rely entirely on computer

tutorials only" (pg. 156) FD learners were significantly more favorably inclined toward using solely CAL.

Chan (1997) reported results in support of Diaz & Cartnal (1999) and Oh and Lim (2005). She administered pre and post- music course surveys as well as interviews and concluded that learners with field sensitive tendencies (which equates to FD according to Wittrock as cited in Chan, 1997-requested) felt strongly that a human instructor was needed for learning as in a traditional delivery format. This was consistent at a significant level both before and after the course indicating that the course experience had not changed their preference. Learners with field insensitive tendencies (which is equated with FI by Wittrock as cited in Chan, 1997-requested) were fine with just CAL.

Based on Motter and Hodgson's evidence (1998), Buch and Bartley (2002) proposed that Kolb's divergers, "being social learners" (p. 6) would prefer a traditional classroom-based delivery format, that Assimilators would prefer a print-based format, and accommodators and convergers would both prefer CAL when they investigated the relationship between learning style and training delivery format preference using the Kolb LSI. Significant delivery mode preference differences were found for different learning styles- most preferred classroom-based learning. This was the predicted response for divergers. If the overall preference for classroom-based learning was removed, second choice for Assimilators was print-based format and for accommodators was CAL. These differences were significant. As predicted, convergers also selected CAL as a second choice but this finding was not statistically significant. These outcomes are consistent with Bohlen and Feratt (1993) and Bozinoleos (1997). Bohlen and Ferratt found convergers to be the most satisfied with CAL and the group least satisfied with

traditional lecture. Bozinoleos (1997) found convergers to have lower computer anxiety scores than divergers.

Divergers on the other hand reported higher computer anxiety scores (Bozinoleos, 1997). They have been shown to demonstrate the strongest preference for classroom-delivery format over the other learning style groups (Buch & Bartley, 2002) and to be the least satisfied with CAL (Gunawardena, & Boverie, 1993). There has been indication that this could relate to divergers being social learners and tending to feel isolated when working online (Motter & Hodgson, 1998; Ross, 1997). Bergman and Fors' (2005) offer the observation that according to "Kolb theory, diverging-preference persons with their concrete perceiving and reflective observation are predicted to be the least interested in computer work" (p. 10) as a possible explanation for these findings and the fact that Bergman and Fors (2005) observed divergers to rate the lowest in their attitude toward computers.

Research regarding learning style's relationship to preference for CAL appears muddled. It would seem, however, from learning style model characteristic descriptions, available literature, and study results that learners who tend to be more feeling and compassionate, more random and imaginative, or more social and interactive are less likely to prefer CAL over traditional delivery methods.

Learning Styles and Success with CAL

Studies have shown persons with certain learning styles are more or less successful with CAL. This is viewed as relevant to the current research based on Larson's (1992) findings that students preferred the delivery method that produced the highest scores.

Chang (1997) found significant differences between FD and FI performance using CAL, with FI performing better than FD. This corresponds with Enoch et al. (1984) who looked at achievement differences between Navy Yeomen and found that those successful in the traditional group preferred reading as a learning style and showed a desire to work with people. The successful CAI group was strong in logical reasoning and showed a preference to work with inanimate objects.

Success in a traditional format was linked to individuals who preferred reading as a learning style and showed a desire to work with people (Enoch et al., 1984). A preference to work with inanimate objects was associated with achievement using CAI (Enoch et al.). This parallels Marwhinney and Saraswat (1991) results showing a significant strong negative correlation with Introversion/ Extraversion dimension with introverts attaining higher grades than extraverts. Marwhinney and Saraswat (1991) also reported a significant strong negative correlation with Sensing/ Intuitive dimension with intuitives attaining higher grades than Sensors.

Davidson, Savenye, and Orr (1992) posited that some learning styles may be more effective than others for learning computer application course content. They found that students who preferred loose structure didn't do as well as those who prefer strong structure. Davidson, Savenye, and Orr showed significant correlation between AS and AR learning styles with a strong AS style resulting in significantly higher scores and a strong AR style resulting in significantly lower scores. Abstract learners as a group have demonstrated significantly higher achievement with lecture than CAL (Ester, 1995) and even been shown to produce lower scores from pre to post test (Ross & Schultz, 1999).

In contrast, abstract learners took less time to complete tasks and scored consistently better than concretes; significantly so in one study for comprehension and in one study for accuracy (Bostrom, Olfman, & Sein, 1990). Abstract random learners have been found to learn significantly more than other learning styles when using CAL (Miller, 2004). Miller reported abstract random learners to have learned more than CS learners by 21.2%, followed by CR learners who learned 15.6% more than CS learners. This also supported her other significant correlation with CS and performance; those with a high CS tendency earned a low final score while those with a high CR tendency earned a high final score. Concrete learners as a group performed equally well with CAL or lecture (Ester, 1995).

Thomas, Ratcliffe, Woodbury, and Jaman, (2002) compared active learners and reflective learning styles in computing classes. Many reflective learners also attained significantly higher scores than active learners in research conducted by Allert (2004) some reflectives attained scores greater than 90% and few reflective learners failed. No active learners appeared in the 90% or higher scores and many of them failed the course (Allert, 2004). This is curious since actives have been shown to take less time and score significantly higher than reflectives in accuracy using CAL (Bostrom, et al., 1990).

Verbal learners produced a similar trend attaining significantly higher scores than visuals (Bostrom, et al., 1990), some in the greater than 90% success bracket while no visuals had scored that high (Allert, 2004). The results for sequential and global learners were more mixed with sequential learners scoring higher than globals on coursework but lower on exams (Bostrom, Olfman, and Sein, 1990).Sein and Roby (1991) recorded convergers AE and AC as having the highest performance over other learning styles with

CAL. This would be in line with Bohlen and Ferratt (1993) who showed assimilators performing 10 points better with lecture and equally well with CAL

Findings again appear mixed for LS and relationship to success with CAL as the prior discussed relationships for preferences and interactions. There does seem to be a trend toward learners with introverted, intuitive, reflective, and auditory tendencies to rate higher in performance with CAL

Learner Concerns with CAL

Learners have been reported negative attitudes toward CAL with lack of feedback, and lack of student – instructor interaction cited as negatively viewed aspects of CAL (Lynch et al., 2002; Payne & Day, 1984). Even when the overall response to CAL is positive, individual style concerns have been cited as the reason for still preferring traditional format delivery over CAL (Lynch et al., 2002; Al-Othman, 2004). Lack of socialization and interaction (Al-Othman, 2004; Diaz & Cartnal, 1999; Lynch et al., 2002; Oh & Lim, 2005; Park & Wentling, 2007; Shaw & Marlow, 1999; Valenta, Therribault, & Dieter, 2001), lack of feedback (Oh and Lim, 2005; Park & Wentling, 2007), discomfort with the computer (Bergman & Fors, 2005; Shaw & Marlow, 1999) and need for extra skills to work with the computer (Chan, 1997) were the most frequently encountered issues cited as detractors from CAL.

Students reported that reduction in face to face interaction results in fewer subtleties like voice inflection (Graff, 2003; Valenta, Therribault, Dieter, 2001) and non-verbal cues (Graff, 2003) as well as less feedback and discussion Lynch et al. (2002). Students named a lack of teacher-student and student-student interactions as why they preferred traditional delivery format. More than 59% of learners in classes studied by Al-

Othman (2004) indicated an overall positive response to CAL as an effective tool but replied less favorably regarding their ability to learn from a computer course compared to a traditional one. The learners listed decreased social interaction as the biggest negative of CAL along with an inability to discuss issues with class mates, forced independence, and a need for technology experience (Al-Othman, 2004). These concerns would indicate that learners who are more social, interactive, and in need of feedback would be less likely to prefer CAL over a traditional delivery

The above issues relating to learning styles are not the only possible influences to consider when looking to transition to a CAL system. Gender (Al-Othman, 2004; Chan, 1997; Ong & Lai, 2006), age , and computer experience (Bozionelos, 1997; Shaw & Marlow,1999)are characteristics that have also been investigated for impact on an individual's learning preferences regarding CAL.

Gender and CAL or Traditional Format Preferences

Females and males interact differently with computer technology (Inkpen, 1997). Technology has been dubbed "the new boys club" (Lee, 2003, p. 488). Males are typically more involved with (Al-Othman, 2004) and more comfortable with computer technology (Al-Othman, 2004; Chua, Chen, & Wong, 1999; Lui &Al, 1990) including CAL (Shaw & Marlow, 1999). Males place a significantly greater importance on technology than females (Ausburn, 2004). They also have significantly higher levels of computer self-efficacy, perceive the computer as being more useful and more user friendly, and men have a significantly higher intention to use CAL than women (Ong & Lai, 2006).

Some studies have found no significant differences in the way men and women view the computer for learning (Christensen, 1999; Wu & Hiltz, 2004)Some studies have indicated that men are more positive toward and have greater use of computers (Yang & Lester, 2004). The literature still shows, "consistent with cultural stereotypes, [that] males tend to be more interested in technology-related topics than females"(Weber & Custer, 2005), and a gender gap does exists with men consistently reporting lower levels of anxiety (Lui, Reed, & Phillips, 1990), greater levels of experience, higher levels of skills, and higher levels of self confidence in using computers (Lee, 2003; Liu, Reed, & Phillips, 1990) and software (Everett, n.d).

User friendliness is one of the most important factors for both men and women in their actual intention to use a CAL system (Ong C.S. & Lai J.Y., 2006). Anxiety is noted as one of the biggest hurdles for both genders of instructors and participants to overcome when implementing a CAL system (Edelson, 1998). Anxiety is also one of the elements found to "put off" women from technology, along with, motivation, cognitive style differences, and access (Campbell, 2000). It has been proposed that women's computer anxiety may be a social construct compounded by male dominance in technology games and professions. A consistent pattern has been seen of females being "put off" from technology establishing itself in the early years of school (Campbell, 2000).

These inequities may contribute to the findings that men believed significantly more strongly than females in the computer as an effective work tool during a CAL pretest (Chan, 1997), men and women demonstrate significantly different social and interactive behaviors when participating in online courses (Barrett & Lally, 1999), females have a higher drop out rate from online courses (Hoyer, nd,

http://www.mtsu.edu/itconf/proceedings/09/HoyerITConferencePaper2009.pdf), and men report a significantly stronger preference for using CAL than women (Abouserie et al., 1992).

Male and female users generally take different approaches to the use of technology (Gunn, McSporran, Macleod, & French, 2003). Gender is therefore an important consideration when implementing a CAL system. Managers must realize that CAL may be perceived by men and women differently (Ong & Lai, 2006).

Literature of the 1990's reported that women of all ages had fewer opportunities and less skill using technology than males (Bush, 2006) and that both males and females held the belief that the world of computer use was more appropriate for men (Wilder, Makie, & Cooper, 1985). More current information points to a decrease in such issues (Gunn, McSporran, Macleod, & French, 2003) with women having more opportunity in previously male-dominated domains (Anthony, Clarke, & Anderson, 2000) but there is still support in the literature for gender differences concerning confidence with (Lee, 2003), and acceptance of computers; as well as preference for (Abouserie et al., 1992), and intent to use CAL (Ong & Lai, 2006).

Studies have indicated that men are more positive toward and have greater use of computers (Yang & Lester, 2004). The literature still shows, "consistent with cultural stereotypes, [that] males tend to be more interested in technology-related topics than females" (Weber & Custer, 2005) and a degree of gender gap still exists with men consistently reporting , greater levels of experience, higher levels of skills, and higher levels of self confidence in using computers (Lee, 2003) and software (Everett, n.d.).

Experience and CAL or Traditional Format Preferences

One of the variables we have reviewed concerning CAL is differences in men's and women's levels of computer experience. Women were found to have lower levels of perceived computer experience than men (Ballou, 2008). They may also underestimate their actual level of computer experience (Ballou, 2008). This could influence women's preference for learning delivery format as levels of perceived computer experience has been directly correlated with actual levels of computer experience (Ballou, 2008).

A greater degree of computer experience increases positive attitude toward computers (Baldi, 1997; Marquiéa, Thona, & Baracata, 1994), decreases computer anxiety (Ballou; Bozionelos, 1997; Chua, Chen, & Wong, 1999; Oh & Lim, 2005) and correlates with greater comfort in using computers and CAL (Czaja & Sharit, 1998; Shaw & Marlow, 1999). It has also been shown to result in significantly higher scores (Brumini, 2005). Similarly technology familiarity (Christensen, Anakwe, & Kessler, 2001) and CAL experience (Oh & Lim, 2005) were also positively and significantly correlated to CAL receptivity. Conversely preference for traditional learning was negatively related to CAL receptivity (Christensen, Anakwe, & Kessler, 2001).

Students with more positive CAL experience have a more positive attitude toward CAL (Oh & Lim) and a significant correlation has been established between a positive attitude toward CAL and preference for CAL, (Oh & Lim, 2005). Gallagher, Dobrosielski-Vergonia, Wingard, & Williams (2005) illustrated that experience in a CAL course influences selection of course delivery method. In Gallagher et al.'s research it was discovered that nearly 75% of learners who selected CAL instead of traditional delivery course had previously taken a CAL course whereas less than 50% of the students

who selected the traditional course had experience with CAL. Profiles of the participating students also revealed that the students who preferred the web-based format had greater computer and CAL experience than the students who preferred the traditional course.

Day and Payne (1984) reported no relationship between CAL preference and computer experience, while Keller and Cernerud (2002) found low experience to be associated more positive attitude toward computers and in the middle of these Forman & Pomerantz (2008) who found that 84%-89% of students preferred learning by lecture. Forman and Pomerantz (2008) did also show that those with the highest computer skills were significantly more in favor of CAL.

Research above appears to support some level of computer and CAL experience influencing receptivity to and preference for CAL. There looks to be a positive relationship between perceived computer experience, actual computer and CAL experience, lower levels of computer anxiety, and preference for CAL.

Age and CAL or Traditional Format Preferences

It is a commonly held belief that older adults are less comfortable with and more resistant to the use of computers than younger people (Czaja & Sharit, 1998). This belief would imply that older adults would prefer the traditional format of learning delivery where as younger ones would be more receptive to CAL.

Age has been found to have a direct and sometimes significant effect on attitude towards (Chan, 1997; Marquiéa, Thona, & Baracata, 1994) and anxiety level associated with the computer (Marquiéa, Thona, & Baracata., 1994). Age has also been shown to be an influence in type of CAL activity preferred (Schaller et al., 2007), preference for

interactivity in CAL (Christensen, 2001), and post-test scores during a CAL course (Brumini, 2005). Preference for or aversion to computer use and CAL in general also have a relationship with age (Chan, 1997; Gallagher, Dobrosielski-Vergonia, Wingard, & Williams,2002; Graff, Davies, & McNorton, 2004).

Older adults have been found to be less receptive to technology and to pay more attention to the human aspects of technology (Chan, 1997). Younger learners seem more receptive and have actually preferred the computer to a human teacher (Chan, 1997). Older participants in one study preferred CAL at the start of the course but were significantly more negative after taking the course. They saw the learning method as too dehumanizing with just a computer and felt the need for a human instructor. The younger participants, however, were fine without a human. This need for human intervention may account for why Fell, Glasgow, Boles, & McKay (2000) found a negative relationship between age and interest in a CAL program to control diabetes: younger people were more interested than older adults. The same as Several Graff, Davies, & McNorton (2004) who found no significant effect for age but their youngest participants (17-19 year olds) were significantly more positive toward the CAL program than 21-32 year olds.

Conversely, (Orr, Allen, Poindexter, 2000) saw that older learners had a significantly more positive attitude toward computer use for learning at the end of a course and viewed the computer as less dehumanizing than they had viewed it prior to the CAL course (Marquiéa, Thona, & Baracata, 1994). This is more in line with Dobrosielski-Vergonia, Wingard, & Williams (2005) who's research showed the older

group of participants preferred the online format and the younger students preferred to take the course in a traditional format.

It can be seen by the above findings that there is some evidence to support the stereotype that older adults do not care for CAL. There is also evidence to the contrary. Overall, it appears that age has some influence on preference for or against the computer as a learning tool but the relationship is not clear.

METHODS

This research was approved by the Northern Michigan University IRB, project number HS08-209 (see letter in Appendix C)

Participants

All participants were employees of DCHS who were completing yearly mandatory safety training. From a pool of 647 employees, a total of 270 subjects participated in the study; (37 males and 233 females). One subject was removed due to marking all "a" answers and 40 subjects were dropped due to lack of prior participation in the traditional-format-training delivery, resulting in 229 usable subjects who met the study criteria of having participated in prior traditional-format-safety training and current computer-assisted-safety training.

Participants had varied levels of computer experience. Some employees used computers daily at work and others had never before used a computer professionally or personally.

Participant occupations encompassed all types of positions in the healthcare system: the categories, as defined by the hospital, are administration/finance/office/registration, nursing, patient-care non-nursing, and service and support. Females in the study had the highest representation (33.2%) in nursing followed by 30% in administration-finance-office-registration where as nearly half (48%) of the males represented patient-care non-nursing. The remaining occupational groups were much smaller as shown in table 1.

Table 1
Employment Position by Sex: Frequency Distribution

Sex	Employment Position	Frequency	Percent
Female	nursing	67	33.2
	admin-finance-office-registration	60	29.7
	Pt. care-non-nursing	46	22.8
	service-support	29	14.4
	Total	202	100.0
Male	Pt. care-non-nursing	13	48.1
	service-support	6	22.2
	admin-finance-office-registration	5	18.5
	nursing	3	11.1
	Total	27	100.0

Instruments

Two instruments were used, a demographic survey and the Felder Silverman Inventory of Learning Styles. They were administered as a single two-part survey. The surveys were made available in both a centrally distributed paper version and as an electronic format from within the training software. This was done to accommodate participant preference and facilitate accessibility.

Demographic Information Survey

The demographic survey consisted of 14 questions asking about, age, sex, employment position, pre-CAL training concerns, post-CAL training concerns, overall preference for training delivery method, and self-rated computer experience. This survey was developed by the author to collect quantitative data in the areas described above and can be found in Appendix 1. The survey age categories in question two were adjusted to be equal 5-year increments. These were later regrouped for statistical purposes into three categories: young (23-37), middle age (38-52), and older (53-62 and older). Employment

position categories were labeled to match the terminology and generally accepted work divisions already established by the employees in the hospital setting. Self-assessed computer experience was reported on a scale of one to five. A label was included with the *one* rating and the *five* rating for clarity: the *one* rating was labeled *nearly new* in addition to *new*. This was done because lesser computer-experienced employees were given the opportunity to participate in a one-hour computer training session prior to taking the training. This one-hour session constituted the only computer exposure given to some employees, but such experience may disqualify them as *new* in the computer-experience category. Question five collected each individual's self-perceived level of computer experience. A single item question was used rather than multiple questions for sake of expediency and since "it has been demonstrated that correlates very highly with the combined results of multi-item instruments" (Ballou & Huguenard, 2008, pg. 88) and perceived computer experience is strongly correlated with actual computer knowledge (Ballou & Huguenard, 2008). Question six was included to prevent employees who had never participated in the traditional pen-and-ink format of The Blitz from answering comparison questions between the two formats since they lacked the experience of the traditional format. This eliminated 40 employees from further participation in the research. Questions nine and ten separate the one item of greatest concern from all items of concern. Question eleven was included to prevent those who did not participate in the introductory computer workshop from rating the workshop information and facilitator. Questions twelve and thirteen were to be answered only by employees who participated in the introductory computer workshop and were included for workshop feedback. An

open ended question allowing participants to suggest future training subjects was added as question fourteen for the benefit of hospital administration.

Felder/Soloman Inventory of Learning Styles

This survey includes 44 questions which comprise the Felder/Silverman Inventory of Learning Styles learning style assessment instrument. The ILS is a survey of 44 forced-choice questions used to assess learning preferences of adults based on a learning style model formulated by Richard M. Felder and Linda K. Silverman. It was developed by Richard M. Felder and Barbara A. Soloman of North Carolina State University in 1991 (Felder & Spurlin, 2005), and has been used in numerous published studies (Steinke, Huk, & Floto, 2003; and is submitted online hundreds of thousands of times per year (Felder & Spurlin, 2005).

The ILS questions are broken into four categories each with parallels in other established learning style models. The four categories are sensing/intuitive, active/reflective, visual/verbal, and sequential/global (Felder, n.d.). As with similar learning style models the measurements of the four dimensions of the Felder/Silverman learning styles model are continuous and therefore an individual's preference may be mild, moderate, or strong-not a yes or no. These preferences are indicators of behavioral tendencies which may correspondingly occur much more often, as described in a category, if the preference is strong and only slightly more often if the preference is mild (Felder & Spurlin, 2005). Felder emphasizes that the ILS results are considered tendencies. He also iterates that the ILS is not appropriate for labeling individuals as strong or weak in either the preferred or less-preferred category (Felder & Spurlin, 2005), it "does not reflect a student's suitability or unsuitability for a particular subject or

discipline, or profession," but it is suggested that the instrument is considered a viable tool for producing "an indication of an individual's learning preferences and an even better indication of the preference profile of a group," such as a class of students.(Felder, n.d.).

This viability of Felder-Silverman's system for this study is further supported by reliability and validity studies conducted regarding the ILS, although it should be noted that "the ILS was developed for use by college students and has only been validated for people of college age and older" (Felder, n.d.). Felder & Spurlin discussed the results of several analyses of ILS responses (2005). In the three test-retest analyses, the correlation coefficient for all four scales of the instrument (Sensing/Intuitive, Active/Reflective, Visual/Verbal, and Sequential/Global) varied between 0.73 and 0.87 at the four-week interval between test administrations, between 0.60 and 0.79 for the seven-month interval, and between 0.51 and 0.7 for the eight-month interval. All coefficients were significant at 0.05 level or better (Felder & Spurlin, 2005).

A variety of reliability and validity studies have been done on the ILS. Felder and Spurlin summarize data from more than a dozen studies in their 2005 article "Applications, Reliability and Validity of the Index of Learning Styles" (Felder & Spurlin, 2005). The reliability and validity information in this section will be based on the findings in this article unless otherwise noted. In looking at construct validity Felder and Spurlin based conclusions on the reasoning that individuals in specific careers or fields of study "display relatively similar profiles from one year to another at similar institutions with those profiles on average, differing noticeably from profiles of students in a much different field" (Felder & Spurlin, 2005 p. 109), (such as engineering versus

humanities). Construct validity was demonstrated through a consistent pattern of learning style preferences of ILS-participating students in numerous studies, one such study taking place at ten universities (Felder & Spurlin, 2005). The profiles of engineering students at seven different institutions and at the same institution in different years consistently showed similar engineering-student learning styles. These students' preferences were reported to be "61% active with a standard deviation of 6%, 63% sensing with a standard deviation of 8%, 82% visual with a standard deviation of 8%, and 59% sequential with a standard deviation of 7%" (Felder & Spurlin, 2005 p. 109). Given these results Felder and Spurlin concluded that "undergraduate engineering students at a variety of different institutions are therefore consistently more active than reflective, and more sensing than intuitive, much more visual than verbal, and more sequential than global (2005, p. 109)." In contrast to humanities students who reported significantly higher verbal preferences as would be expected in such a field versus a fields with a science focus. (Lopes, 2002, as cited in Felder & Spurlin, 2005).

The internal consistency or reliability of each scale, Cronbach's alpha coefficient, was above Tuckman's criterion value of 0.5 for attitude surveys (Tuckman, 1999) in three of four studies. They were also greater than 0.5 for all but the sequential-global dimension in the fourth study conducted by Zywno (Zywno, 2003) who points out that the "widely accepted social science cut off [for Chronbach's alpha] is 0.7". She does, however, acknowledge Tuckman's statement that "alpha test reliability should be above 0.75 for achievement tests but only above 0.5 for attitude tests" (Zywno, 2003, para. 2).

Orthogonality of scales has also been reasonably established through multiple studies (Felder & Spurlin, 2005) to the conclusion that the sensing-intuitive and

sequential-global scales show a significant correlation, with r calculating as high as .55, but the other three scales showing relative independence" (Felder & Spurlin, 2005 p. 109).

The ILS was chosen based on its recommended uses and the reliability and validity support. It was also chosen because of its availability to individuals, instructors, or students who wish to assess their own preferences or use the ILS for classroom instruction or research (Felder & Spurlin, 2005).

Procedures

The study took place using a convenience sample over the course of five months in conjunction with employer-required annual safety training. The training was delivered in two waves. The first group to whom the training was delivered was the lab services and the service and support employees. These groups were chosen to be the first wave based on management feedback that these employees were on the low end of the computer experience scale and would require access to and assistance with computers.

This first wave was granted access to a hospital computer lab as well as access to a 1-hour introduction to computers session. The second wave of the training included the remainder of the healthcare workers and was made available on computer terminals in the work areas. Employees of both waves were also provided written instructions to access the training from offsite.

On completion of the annual safety training employees were asked to volunteer to participate in this two-part survey. The survey was made available in both traditional paper and non-traditional electronic formats to the first wave in order to facilitate accessibility given that there was very limited computer access in these work areas. The

electronic version was made accessible to both waves anonymously online from inside the training software and had participation consent form as the first page of the survey file. The paper version was made available in a central location in each department and also asked for no identification; a consent form was attached and was removed before submission.

Separate sealed and marked containers were placed in a central location in the hospital where consent forms and surveys could be submitted separately and anonymously. Electronic submissions were downloaded and paper submissions were manually keyed into SPSS software which was used for statistical analysis.

RESULTS

An overall preference for the computer assisted learning delivery method was found with 151 participants preferring computer delivery method and 76 participants preferring traditional delivery method.

Statistical results will be reported using a .050 level of significance. Total N will vary slightly as a function of omitted answers. No single subject omitted more than 3 answers.

Hypothesis 1: "Older adult learners will favor traditional methods of training delivery".

Qualified participants ranged in age from 23 years to more than 62 years and both males and females were represented in each category. The middle age (38-52) category was the most frequent age group in both sexes with smaller numbers in the other age groups as shown in table 2.

Table 2
Age Representation of Participating Subjects

Age Group	Frequency	Percent
23-37	49	21.4
38-52	114	49.8
53-62+	66	28.8
Total	229	100.0

To test this hypothesis, a chi-square test of independence was done between age and training delivery method preference. The initial chi-square included too many low frequency cells so age was regrouped into three categories as shown in table 3. No preference by age relationship was found, χ^2 (2, N=227) = 2.71, p>.05.

Table 3
Learning Delivery Method Preference of Age Groups

Age Group	Prefer Computer	Prefer Traditional	% Prefer Computer	% Prefer Traditional	% Difference
18-37	37	12	76%	24%	52%
38-52	71	43	62%	38%	24%
53-62+	43	21	67%	33%	34%
Total	151	76	67%	33%	67%

Hypothesis 2: "Female adult learners will favor traditional methods of training delivery".

To test this hypothesis, a chi-square test of independence was done between sex and delivery method preference. There was no preference by sex relationship, χ^2 (1, N=227) = .57, p> .05.

Approximately 70% of both males and females reported a preference for computer over traditional delivery method, with a female response rate of 132 preferring computer and 69 preferring traditional, and a male response rate of 19 preferring computer delivery and 7 preferring traditional.

Hypothesis 3: "Adult learners with more computer experience will favor CAL methods of training delivery".

To test this hypothesis, a chi-square test of independence was done between computer experience and delivery method preference. Self-assessed experience level was regrouped into three categories from the original five due to small numbers in separate experience level groups. The resulting categories were labeled "high", "medium", and "low" levels of experience. A preference by experience relationship was found. χ^2 (2,

N=227) = 8.49, p< .05. It was found that preference for computer-format delivery increased as self-rated-computer experience increased.

Hypothesis 4: "Adult learners who prefer CAL will have learning style tendencies of reflective, visual, sensing, and sequential-as categorized by Felder and Soloman's Index of Learning Styles (ILS)."

Learner ratings on each ILS scale were calculated using a -11 to 11 range with positive scores up to 11 indicating the active, sensing, visual, and global end of the scales and negative scores indicating the reflective, intuitive, verbal, and sequential end of the scales.

To assess scale differences as a function of training preference, an independent groups t-test was run for each scale. Table 4 shows the means and standard deviations on each scale for each preference and Table 5 shows the results of each t-test. On the Active-Reflective scale, those learners who preferred computer training scored higher on the active end of the scale than those who preferred traditional training, t(225) = 7.57, p = .000. On the Sensing-Intuitive scale, those learners who preferred computer training scored higher on the sensing end of the scale than those who preferred traditional training, t(225) = 5.36, p = .000. On the Visual-Verbal scale, those learners who preferred computer training scored higher on the visual end of the scale than those who preferred traditional training, t(225) =, 7.23 p =.000. On the Sequential-Global scale, those learners who preferred computer training scored higher on the sequential end of the scale than those who preferred traditional training, t(225) =, 7.23, p =.000.

Table 4
Mean, Sd, and Confidence Intervals for Learning Styles by Preference

Learning Style Scale	Preference	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min	Max
Active_Reflective	computer	151	10.02	2.911	.237	9.55	10.49	-9	11
	traditional	76	5.87	5.350	.614	4.65	7.09	-5	11
	Total	227	8.63	4.356	.289	8.06	9.20	-9	11
Sensing_Intuitive	computer	151	9.99	2.249	.183	9.63	10.36	-3	11
	traditional	76	7.72	4.127	.473	6.78	8.67	-5	11
	Total	227	9.23	3.188	.212	8.82	9.65	-5	11
Visual_Verbal	computer	151	9.78	2.663	.217	9.35	10.21	-5	11
	traditional	76	6.26	4.663	.535	5.20	7.33	-7	11
	Total	227	8.60	3.833	.254	8.10	9.10	-7	11
Sequential_Global	computer	151	9.19	1.991	.162	8.87	9.51	-1	11
	traditional	76	5.87	4.903	.562	4.75	6.99	-5	11
	Total	227	8.07	3.615	.240	7.60	8.55	-5	11

Table 5
t-test on Each ILS Sale by Preference

Learning Style Scale	F	Sig.
Active_Reflective difference	7.57	.000
Sensing_Intuitive difference	5.36	.000
Visual_Verbal difference	7.23	.000
Sequential_Global difference	7.23	.000

Between each pair of learning style dimensions there was a significant correlation with the active-reflective dimension and the visual-verbal dimension resulting in the highest correlation as shown in table xx $r(227) = .755$, $p = .000$ demonstrating a failure to replicate the orthoganality of the four scales, which several other studies have found with

the exception of the sensing-intuitive and global sequential dimensions which was found to be the second strongest correlation in this study, $r(227) = .683$, $p = .000$ as shown in table 6.

Table 6
Pearson Correlations Btween Learning Styles

		Active_Reflexive difference	Sensing_Intuitive difference	Visual_Verbal difference	Sequential_Global difference
Active_Reflexive difference	Pearson Correlation	1	.485**	.755**	.649**
	Sig. (2-tailed)		.000	.000	.000
	N		229	229	229
Sensing_Intuitive difference	Pearson Correlation	.	1	.537**	.683**
	Sig. (2-tailed)			.000	.000
	N			229	229
Visual_Verbal difference	Pearson Correlation			1	.667**
	Sig. (2-tailed)				.000
	N				229

**. Correlation is significant at the 0.01 level (2-tailed).

SUMMARY AND CONCLUSIONS

This study sought to evaluate whether or not relationships exist between an individual's preference for or against CAL and the potential influences on that preference: specifically learning styles, self-rated computer experience, gender, and age. These results add to the body of research concerning the growing use of computer assisted learning and how it is perceived and accepted by learners.

Results indicated that no significant relationship was found between learning format preference and sex or age. That no significant relationship was found between learning delivery format preference and sex is not as predicted and runs contrary to a number of studies in the literature (Abouserie et al., 1992; Barrett & Lally, 1999; Hoyer, nd; Ong & Lai, 2006; Yang & Lester, 2004). This result may be unexpected but is not unprecedented. Christensen (1999) found no correlation between gender and CAL receptivity. Wu and Hiltz (2004) proposed and found support for their hypothesis that there would be "no difference between female and male students in perceptions of learning, motivation and enjoyment from online discussions" (p. 146). The existing literature provides such a breadth of gender differences regarding computers that perhaps future studies examining this aspect would reveal a closing of the gender gap as implied by Gunn et al. (2003) and Anthony, Clarke, & Anderson, (2000) in regard to computers and CAL.

While there was no significant finding between age and preference, it was noted that the youngest age group (18-37 year olds) had the greatest number of learners who preferred computer format delivery to learners who preferred traditional delivery-a 3:1 ratio. The other groups were approximately a 2:1 ratio of preference for computer to

preference for traditional learning delivery format. Also, when looking at each age group separated by sex, the 62+ age group for women actually saw a 6:4 preference for traditional delivery. This was the only combined age and gender group showing a preference for traditional-format delivery. Again, types of changes discussed above, may indicate the possible lessening of the gender gap. This combined with the younger age at which people are now being exposed to computers would be interesting to examine at a future date to see if this trend for the eldest women preferring traditional learning delivery format shows signs of reversal.

The findings for computer experience were both significant and as predicted: learners with higher levels of perceived experience preferred CAL where as learners with lower levels of perceived experience were less receptive to CAL. Since perceived level of perceived computer experience has been directly correlated with actual level of computer experience (Ballou, 2008) this finding agrees with Christensen, Anakwe, and Kessler (2001) Oh and Lim (2005) as well as Gallagher et al. (2005) and Forman and Pomerantz (2008) who's results both showed that those with the highest computer skills were more in favor of CAL.

Three of the significant relationships found between learning styles and learning delivery format supported hypothesis four. One did not: CAL preferring learners in this study were more active than reflective. The fact that any significant relationship was found runs contrary to Bush (2006) Keller and Cernerud (2002) Oh and Lim (2005), and Ross and Lukow (2004) but adds support to such researchers as Ames (2003); Buch and Bartley (2002); Leuthold (1999), Smith, Munday, and Windham (2002); Chambers, Hardy, Smith, and Siety (2003); and Zapalska & Brazik (2006), The prediction was that

if relationships did exist CAL preferring learners would be more reflective, sensing, visual, and sequential in their learning style.

It was thought that since CAL environments require a greater use of reflective observation (Argon, 2002) and independence (Oh & Lim, 2005), and reflective learners are more solitary and introspective for information processing (Felder & Silverman, 1998), they would prefer a CAL environment. CAL preferring learners were however found to be more active. This runs contrary to findings of outward focused individuals (such as those found to be active or extroverted) and higher levels of computer discomfort by Korukunda (2006). It also contradicts Buch and Bartley's (2002) results that reflective observation learners preferred print and traditional delivery formats not CAL. Therefore, this finding warrants further investigation.

Smith, Munday, and Windham (2002) reported sensory individuals to be less comfortable with computers. Chambers, et al. (2003) reported intuitively inclined individuals tend to use technology more than their sensing counterparts; and intuitives have been shown to have a greater acceptance of technology (Chambers et al., 2003) than sensors. However, this study showed CAL preferring learners rated strongly on the sensing scale. Since sensors naturally perceive information concretely through their senses and prefer facts and data (Felder and Silverman, 1988) this is not an unexpected finding. Their opposites in information perception, abstract learners, have demonstrated significantly higher scores with traditional learning and even shown a decrease from pre to post test when using CAL (Ross & Schultz, 1999) so it is unlikely that those who perceive through abstract conceptualization would prefer the CAL learning delivery method. Sensors themselves, have been found to rate highest in satisfaction with CAL

courses (Ahn, 2000) while intuitive individuals have reported least satisfaction (Al-Othman, 2004). The evidence, including the results of this study, support that sensors would prefer CAL learning delivery methods and their counterparts would be partial to traditional methods.

The global/sequential scale showed CAL preferring learners to be significantly more sequential than global. This would stand to reason as computers are generally viewed to function in a logical and orderly fashion and CAL environments require strong analytic capabilities (Oh & Lim, 2005). Logical progression would naturally appeal to the sequential learner's step-by-step and logical learning tendencies. It would also be contrary to the big-picture type of thinking, in large leaps and chunks, that global learners exercise (Felder & Silverman, 1988). Both Ames (2003) and Leuthold (1999) found learners with high sequential tendencies preferred CAL over traditional delivery methods and that learners with a highly sequential learning style were more confident in using a computer for CAL (Ames, 2003). Along with demonstrating more frequent use of the computer in the classroom, sequential learners also perceived an increase in motivation when using the computer for learning (Leuthold, 1999).

There was only a small amount of information found in the literature regarding the visual/verbal scale and computer preferences. It includes Zapalska and Brazik (2006) concluding that auditory learners may not prefer CAL after a total of only two students, from a sample spanning two online courses during two different semesters, possessed auditory tendencies as their primary learning style. This finding coupled with the characteristics of visual and verbal learners was the basis for predicting visual learners would be more likely than verbal learners to prefer CAL. Visual learners prefer to learn

through images and visual presentation which a computer can accommodate (Felder and Silverman, 1988). Verbal learners greatly prefer discussion, communication, and other forms of auditory input (Felder and Silverman, 1988). The computer as a learning tool can provide sounds, but given its inanimate nature, it may actually hamper verbal discussion and communication. This was seen as a severe drawback when considering learning delivery methods for verbal learners. As technology grows and new forms of interactive media become available this is one aspect of CAL that may change, warranting examination in the future.

Transitioning from traditional training delivery to CAL may present challenges for individual users and for the organization because of differences in the individual users. This study did not find significant relationships with age or gender. It did highlight trends in the literature and results noting possible developments to examine in the future.

This study has also added support to the research showing that learner characteristics such as learning style and computer or CAL experience need to be taken into account when implementing a CAL system. Results indicated that active, sensing, visual, and sequential learners prefer CAL. This could indicate that if an organization were comprised of many reflective, intuitive, verbal, or global learners extra steps would need to be taken to smoothly bring these learners through the transition to a CAL system.

A great deal of information is available regarding learners' reactions to and perceptions of computers for learning. Less information was found examining how to create a computer assisted learning environment that learners who may be adverse to CAL would find more user friendly. This is certainly another area, which as new technology becomes available, would be helpful to explore in future research.

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APPENDIX A

Informed Consent for Blitz Training Feedback: Learning Styles Inventory

This form is to obtain consent for participation in a survey to gather feedback for Blitz training and to assess individual learning styles. There are 2 sections to this survey which should take no more than 10 minutes
The Survey section one will include multiple choice questions including single or multiple answer and will evaluate the Blitz training, have you self-rate your level of computer literacy, and gather demographic information for categorizing data. Survey section two will assess your individual learning style. The data from this exercise will be used to evaluate the Blitz training as part of a Training, Development, and Performance Improvement Masters of Science student's research project at Northern Michigan University. By asking current DCHS employees to participate in this survey we will be able to evaluate the new computer-assisted training system and assess how it is impacted by individual differences in learning styles, time of employment with DCHS, and levels of computer skills. The direct benefits of participating are that your concerns and preferences regarding the format of the annual Blitz training will be expressed to DCHS management and administration. The indirect benefits are that the results regarding learning styles may indicate individual learning preferences that should be considered in creating future training. And the results may show that different training is appropriate for new employees verses long-term employees. The risks of participating are no greater than participating in Blitz online training, that is, risks associated with answering questions on a computer.

All data reports will be in grouped form. No individual data will be reported. No names are attached to these data. Neither the evaluator nor DCHS will know whose name belongs with any response; an unrelated number is generated for each group of data submitted so there is no connection between answers and participant. Your participation in this survey is voluntary, no names will be recorded, and there is no penalty for deciding not to respond. You may decide not to continue at any time without penalty. If you choose to participate, your continuation with the computer program will be taken as your consent to participate in this research.
Thank you for considering participation in this survey and the related research. For considering participation whether or not you choose to complete the survey, you are being offered a free chocolate treat by notifying Sherry Smith-LaBrash in the TLC training room or via email at sherry.smithlabrash@dchs.org
This research has been reviewed by a representative of DCHS and the Northern Michigan University Human Subjects Research Review Committee (HSRRC#HS08-209). You may receive more information about the research from Sherry Smith-Labrash in the DCHS TLC training room at extension 3576 email:sherry.smithlabrash@dchs.org or through the NMU Office of Research, Dr. Cynthia Prosen, Associate Provost and Dean of Graduate Studies, Research, and Continuing Education 610 Cohodas Northern Michigan University Phone: 906-227-2300 email: cprosen@nmu.edu Thank you for your participation.

APPENDIX B

DEMOGRAPHIC AND FELDER LEARNING STYLE INVENTORY SURVEY

1. **What is your gender?**
    a. **Male**
    b. **Female**

2. **Which age category best describes you?**
    a. **Under 18**
    b. **18-22**
    c. **23-27**
    d. **28-32**
    e. **33-37**
    f. **38-42**
    g. **43-47**
    h. **48-52**
    i. **53-57**
    j. **58-62**
    k. **62 plus**

3. **How long have you been employed at DCHS?**
    a. **Less than 1 year**
    b. **1-5 years**
    c. **6-10 years**
    d. **11-15 years**
    e. **16-20 years**
    f. **21-25 years**
    g. **More than 25 years**

4. **Into which group does your position best fit?**
    a. **Administration/Office-Patient Registration, Finance, Medical Records, HUCs, ect.**
    b. **Nursing-RN, LPN, Nurse Aide, Tech, etc.**
    c. **Patient Care-Non Nursing-Radiology, Lab, Rehab, Respiratory Care, etc.**

d. **Physician, PA, FNP, etc.**
e. **Service/Support-Maintenance, ES, Dietary, Laundry, Security, etc.**

5. **On a scale from 1 through 5 with 1 being new or nearly new to using the computer and 5 being very experienced, how experienced as a computer user would consider yourself, prior to participating in this year's MC Strategies computer-format Blitz training?**
   a. **1- new or nearly new**
   b. **2**
   c. **3**
   d. **4**
   e. **5-very experienced**

6. **Have you participated in a paper-format Blitz?**
   a. **Yes**
   b. **No**

7. **Comparing the previous paper-format Blitz to this years MC Strategies computer-format Blitz, select which format you believe best fits in each of the following statements.**

	Computer	Paper
The_____format was easier to understand the questions		
The_____format was more difficult to fill out		
The_____format had more detailed questions		
I learned more as an individual with _____format		
I feel I was better able to remember more of the learning with the _____format		
The_____format took less time to complete		
Overall I prefer the _____format for the Blitz		

8. **Prior to taking part in this year's MC Strategies computer-format Blitz training, which of the following best describes your <u>biggest</u> concern about the computer-format Blitz?**
   a. **I didn't have any concerns about it**
   b. **How to use the computer**
   c. **How to use the new MC Strategies software**
   d. **Not having written resource materials**

e. **Not having enough access to a computer**
f. **Other-Please explain**

9. **Did you participate this year in a trainer-led session to learn how to work with MC Strategies and/or the computer for the Blitz?**
   a. **Yes**
   b. **No**

10. Please answer the following about the trainer-led Blitz session.

	Strongly agree	**agree**	**Strongly disagree**	**disagree**
The training was helpful overall				
The training was conducted at a comfortable pace				
After the training, I felt better prepared to participate successfully in this year's Blitz				
After the training, I felt an improvement in my computer using skills				

11. The trainer who facilitate the MC Strategies/computer session …

	Strongly agree	agree	Strongly disagree	disagree
Was knowledgeable				
Was willing to answer questions				
Was respectful of individual learner's needs				
Was clear in giving directions				
Made clear what material was expected to be covered during the session				
Displayed genuine concern for the learners				
Is someone I would be willing to take training from again				

12. If you could choose any type of job-related training to participate in, what one subject would you like to see made available? (i.e. Microsoft Word, Cultural Diversity, Time Management, etc.)

The following questions will help determine your preferred learning styles based on the Felder/Silverman Index of Learning Styles. Select "a" or "b" for the following questions. If "a" and "b" both seem to apply to you, select the one that applies most often.

INDEX OF LEARNING STYLES*

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 C

IRB LETTER OF APPROVAL

Northern Michigan University

Continuing Education
1401 Presque Isle Avenue
Marquette, MI 49855-5301

October 1, 2008

TO: Sherry A. Smith-LaBrash
Psychology

FROM: Cynthia A. Prosen, Ph.D.
Dean of Graduate Studies & Research

RE: Human Subjects Proposal # HS08-209
"Preference for Computer Assisted Learning Based on Individual Learning Styles, Age Grouping, Employment Tenure, and Familiarity with Computers"

The Human Subjects Research Review Committee has reviewed your proposal and has given it final approval. To maintain permission from the Federal government to use human subjects in research, certain reporting processes are required. As the principal investigator, you are required to:

A. Include the statement "Approved by HSRRC: Project # (listed above) on all research materials you distribute, as well as on any correspondence concerning this project.

B. Provide the Human Subjects Research Committee letters from the agency(ies) where the research will take place within 14 days of the receipt of this letter. Letters from agencies should be submitted if the research is being done in (a) a hospital, in which case you will need a letter from the hospital administrator; (b) a school district, in which case you will need a letter from the superintendent, as well as the principal of the school where the research will be done; or (c) a facility that has its own Institutional Review Board, in which case you will need a letter from the chair of that board.

C. Report to the Human Subjects Research Review Committee any deviations from the methods and procedures outlined in your original protocol. If you find that modifications of methods or procedures are necessary, please report these to the Human Subjects Research Review Committee before proceeding with data collection.

D. Submit progress reports on your project every 12 months. You should report how many subjects have participated in the project and verify that you are following the methods and procedures outlined in your approved protocol.

E. Report to the Human Subjects Research Review Committee that your project has been completed. You are required to provide a short progress report to the Human Subjects Research Review Committee in which you provide information about your subjects, procedures to ensure confidentiality/anonymity of subjects, and the final disposition of records obtained as part of the research (see Section II.C.7.c).

F. Submit renewal of your project to the Human Subjects Research Review Committee if the project extends beyond three years from the date of approval.

It is your responsibility to seek renewal if you wish to continue with a three-year permit. At that time, you will complete (D) or (E), depending on the status of your project.

kjm

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