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A STUDY OF THE RELATIONSHIP BETWEEN CBT DEVELOPERS' MULTIPLE INTELLIGENCES DISPOSITIONS AND THE DESIGN OF COMPUTER-BASED TRAINING

A Dissertation

Submitted to the

Interdisciplinary Doctoral Program for Educational Leaders

School of Education

Duquesne University

In partial fulfillment of the requirements for

the degree of Doctor of Education

By

Nancy M. King, M.Ed.

August 2009

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Nancy M. King

2009

DUQUESNE UNIVERSITY
SCHOOL OF EDUCATION
INTERDISCIPLINARY DOCTORAL PROGRAM FOR EDUCATIONAL LEADERS

Dissertation

Submitted in Partial Fulfillment of the Requirements
For the Degree of Doctor of Education (Ed.D.)

Presented by:

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M.A., Education, University of Pittsburgh, 1996
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June 29, 2009

A STUDY OF THE RELATIONSHIP BETWEEN CBT DEVELOPERS' MULTIPLE INTELLIGENCES DISPOSITIONS AND THE DESIGN OF COMPUTER-BASED TRAINING

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ABSTRACT

A STUDY OF THE RELATIONSHIP BETWEEN

CBT DEVELOPERS' MULTIPLE INTELLIGENCES DISPOSITIONS

AND THE DESIGN OF COMPUTER-BASED TRAINING

By

Nancy M. King

August 2009

Dissertation supervised by Dr. John C. Shepherd and Dr. William J. Gibbs

This study assessed the relationship between CBT developers' multiple intelligences (MI) dispositions and their designs for computer-based training programs (CBTs). This study was based on the theoretical framework of the Theory of Multiple Intelligences (MI) and theories about instructional design (ID). Student developers in a class were surveyed using Shearer's Multiple Intelligences Development Assessment Scales (MIDAS), a screening instrument that is designed to determine the students' MIDAS profiles, or their intelligences. The students received instruction in using MI in their CBT design; and, after they had designed their CBTs, four professionals assessed their CBTs for inclusion of MI.

Both quantitative and qualitative data analyses were performed on the association between students' MIDAS profiles and the CBT reviewer ratings. The findings of the correlation and regression analyses of the observations of the qualitative data showed that

some of the CBT design was influenced by the student CBT designers MI as indicated by the MIDAS profiles. Positive significant outcomes were reported for the linguistic, spatial, intrapersonal, and kinesthetic intelligences. These findings show that knowledge of MI was influential on a few of the design variables, as the students were successful in designing CBTs that reflected inclusion of MI for tailoring to learners' needs rather than to designers' preferences. The information gathered in this study will make a significant contribution to the e-learning field because it sheds light on the association of MI with the development of CBTs.

DEDICATION

This dissertation is dedicated to my mother and father

Rudolph and Cecelia (Sala) Tonecha

Mom, you were the one who saw me through all of this. You earned this degree step-by-step alongside me. Both of you have always been very special parents with hearts of gold. I completed this dream because of your love, faith, and belief in me. Thank you for supporting me.

This is for you, Mom and Dad.

I will always love you.

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Rudolph Frank Tonecha (Big Rudy), my father: I always felt your presence, especially when times seemed overwhelming. I knew you were with me watching over me. Your courage and determination to work again after surviving a 40-foot fall, when your scaffolding broke as you worked as an ironworker on the Mellon building, helped me to realize I have the same perseverance factor. You worked hard, as an ironworker (50 years), deputy sheriff in the county, and sergeant of arms on the police force, to give me an education that you wanted for me.

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CHAPTER 1

Introduction

Circumstances Leading to the Problem

A changing technological environment is affecting our 21st century education system because of emphasis on computer technology. Our culture is being radically altered by technology (Gardner, 1993). The rapid growth in the use of learning technologies has offered many opportunities to optimize achievement, and the remarkable advancement of technological tools is reshaping education by gaining the confidence of educators in the ability of technology to enhance the educational process. The results of the most recent national faculty survey from UCLA's Higher Education Research Institute indicate that a full 87% of the faculty feel that student use of computers enhances student learning (Epper, 2001). Hung and Hsu (2007) note how fast the use of computer-based training (CBT) has grown in twenty years, and while CBT grows quickly at home and in schools, it is also influencing instructional strategies immensely.

However, the information explosion and surge of interest in educational technology are creating dilemmas: (a) teachers are bewildered by the array from which they can choose and (b) few guidelines exist for determining the validity of available software in terms of whether or not it is learner-centered and effective. Many concerns have been raised about the effectiveness of the vast range of educational software currently available; some research shows that 90% of software packages are ineffective (Wassermann, 2001). Although it is undeniable that educational software can be used to enrich the curriculum, the choices also place a great burden on teachers to select the most relevant and educationally sound material; clear criteria are not currently available for making such selections (Wassermann, 2001).

Sanders (2002) notes also that the use of educational computer software is growing throughout K-12 and adult education classrooms; however, he contends that this software is not validated for its effectiveness. The lack of validation of effective software is a challenge affecting education, but Veenema and Gardner (1996) perceived that this will have enormous implications for educational practice.

In order for a CBT design to be useful for educational software, we need to capitalize on how the human mind works (Veenema & Gardner, 1996). Modern educational theory has given us a number of ideas for how this might be accomplished. For example, a CBT tends to favor how learning materials and instruction materials are designed. In traditional instructional environments, however, all individuals have often been taught with exactly the same methods, and content has been largely instructor-centered. Gardner's (1996) multiple intelligences (MI) theory purported that educators should design their teaching strategies according to each individual's proclivities. CBTs can easily be designed to accommodate individual learner needs. The goal of supporting learners' ability to understand and interpret new knowledge can be achieved far more successfully with a greater proportion of learners, who have a variety of intellectual styles, if we appropriately design and produce more effective educational materials that mesh with technology (Veenema & Gardner, 1996).

Technology can deliver new forms of knowledge to enhance learners' distinct cognitive abilities (Nickerson & Zodhiates, 1988). Therefore, a strong need exists for CBT software that is learner-centered based on cognition and how humans learn. In addition, there is a need for guidelines that will help educators determine the effectiveness of CBT software and help them select programs that are optimal for their instructional needs. The objective of such technology is to achieve greater success rates by reaching a variety of intellectual styles. Motivated by the power of CBTs and the value of MI, this study aims to assess associations between Multiple Intelligences (MI) and Computer-Based Training (CBT) design with respect to all levels of learners, from kindergartners to adults.

Multiple Intelligences (MI)

In the 1983 book, *Frames of Mind*, Gardner presents his MI Theory, observing that intelligence is highly regarded in our culture, not only for discovering solutions or solving problems but also for innovation (as cited in Shearer, 2008). Gardner's MI Theory includes eight intelligences: musical, kinesthetic, mathematical, spatial, linguistic, interpersonal, intrapersonal, and naturalistic. MI Theory can be defined as the various ways that individuals are intelligent and acquire new knowledge. Gardner recommends that individual proclivities be cultivated because individuals have proclivities, intelligences, and aptitudes that make people differ from one another; individuals who are strong in math will move farther and faster in learning that subject than individuals whose aptitudes are strongest in language or the arts (Eisner, 2004).

MI Theory could enhance the design of CBT if developers design multi-modally, i.e., use multiple methods to accommodate learner individual needs, to tap the potential of learners. This has great implications not only for teachers, but also for instructional designers because they must identify alternative approaches to learning; thus, the creativity of both teacher and developers will increase from enriching their instruction.

Computer-Based Training (CBT)

Computer-based Training (CBT) is any training that uses a computer for instructional delivery. CBT programs can be saved as self-running CDs, embedded into a Web site, or delivered in such a format as a DVD or a mobile device. CBTs are developed with an instructional design (ID) approach that uses the computer to provide interactive education. They are often developed using an instructional design process that typically includes analysis (learner, content, environment), design, development, and formative evaluation phases. Two terms associated with Computer-based Training (CBT) are Computer-based Instruction (CBI) and Computer-assisted Instruction (CAI) because they also refer to instruction provided through the medium of a computer.

Statement of the Problem

The concept of *strongest intelligence* indicates the best-developed ability toward which one is inclined; it is a person's tendency to use his or her own natural propensities or proclivities. Based on research by Chisholm (1998), the design of educational materials for a lesson may have an association with an instructor's strongest MI because instructors frequently teach using their own strengths, which do not always address the strengths of all learners.

According to Shearer’s (2007) Multiple Intelligences Developmental Assessment Scale (MIDAS), the linguistic and interpersonal intelligences were the strongest for Ph.D. educators and high school teachers. High school teachers are expected to have strengths in interpersonal, linguistic, and math. In addition, Shearer stated all teachers are highest on interpersonal and linguistic, elementary teachers are not high on math, and most teachers are not strong in spatial. Vangilder (1995) showed that teachers’ instruction styles are associated with how they present their lessons. Koller, Frankenfield, and Sarley (2000) showed that learners' and teachers' natural proclivities have an association with old categories of information, automated behaviors, and the inability to think from more than a single perspective. Logic would then suggest that instructional designers' level of intelligence for a given component may have an association with the corresponding component of their CBT designs. For instance, a low rating for math intelligence would tend to correspond to a lower use of math intelligence in the CBT design. Thus, educators may incorporate their own strongest intelligence into their teaching and instructional designs.

It also seems plausible that the strongest intelligences of a CBT developer could influence program design, especially when instructional design processes are not followed. Based on research by Hennigan (2000), it appears that an instructional designer's personal predilections or strongest MI may have an association with the choices he or she makes regarding the instruction design for a CBT lesson. Research needs to be extended specifically to examine the extent to which an instructional designer's strongest intelligence influences CBT program design (the interface, media, etc.).

This research study hypothesizes that designers may incorporate their own strongest intelligence into their design. This concept is particularly important for individuals in educational courses who are learning to develop CBTs and for individual developers who are unable to fully implement instructional design practices. When designers follow a systematic instructional design process, learner preferences and needs become a focal point of the design; CBT designs are learner-centered. However, when the instructional design processes cannot be followed because of limited resources (e.g., funding for personnel and equipment, etc.), the preferences of the program developers may supersede those of learners, and CBT designs may become designer-centered. This may occur due to a lack of design iterations or formative evaluations that help to ensure that the learner needs are accounted for. The fundamental purpose of any CBT program must always be learner-centered, focusing primarily on learner needs. When developers design CBTs, if they unknowingly incorporate their natural proclivities or the predispositions from their strongest intelligence, they may orchestrate designer-centered rather than learner-centered CBTs, which may be contrary to effective CBT instructional design.

Knowing that individuals, proficient in many practices, like teachers, draw intuitively on their large knowledge base (Kornhaber, 2004), it is plausible to think that CBT developers may draw intuitively on their own intelligences to design. It is important for designers and developers to understand that they have a strongest intelligence that may influence them during CBT design, particularly when instructional design processes cannot be fully implemented. This awareness may help designers to be more cognizant of individual differences in learner intelligence and overall learning needs, and it may help engender learner-centered designs. This would meet the needs of *all* learners and the CBT would be more learner-centered. More learner-centered CBTs provide more effective instruction, thus giving learners the opportunity to make choices and to take charge of their own learning and possibly increasing confidence and achievement (Tracey, 2001).

Multiple Intelligences (MI) Theory

The current study is needed for several reasons. First, though previous studies have stressed the need to conduct more research on the application of MI Theory (Ozdemir, Guneysu, & Tekkaya, 2006), no substantial amount of empirical literature has been written on the integration of MI Theory into CBT design. No study was discovered on the relationship between CBT developers' MI dispositions and the design of CBTs.

Second, the MI Theory needs to be studied more intensely for post-secondary education at the university classroom level, according to Shore (2001), because without research to support use of this theory, teachers may feel unjustified in using it.

Third, MI Theory also needs to be examined more with reference to high school individuals, according to Dome (2004), who advocates appealing to all intelligences. They argue that students will be at greater risk of failing if instruction continues to focus primarily on only linguistic and logical-mathematical intelligences.

Shearer (2004) states that learning style theories have been with us since the 1950s, and many versions are available to help teachers describe the unique learning preferences of students. He further states that the term *learning style theories* usually refers to personality characteristics or preferences in the process of learning, while MI Theory emphasizes the skill of creating the product, providing a service, or problem-solving.

Instructional Design (ID) Theory

Instructional design (ID) is an iterative review process with phases that are used when designing CBTs in order to meet learners' needs. The process includes a needs assessment, goals and scope, audience analysis, learning objectives, appropriate instructional strategies, an assessment plan, and formative and summative evaluations. A further discussion will be forthcoming in Chapter 2 on ID.

A number of researchers have indicated a need for instructional designers to understand learners' intelligences to aid in the design of instruction. Doing so may motivate individuals and maintain interest, which in turn may increase confidence and an optimal level of achievement (Tracey, 2001).

A study by Long and Smith (2004) accentuated the need to design educational materials in a CBT with MI to provide appropriate opportunities for different learning paths for different individuals, but it did not explore the relationship of the designers' MI to the design of their CBTs. However, while findings have indicated the increasing significance of MI Theory, empirical studies of the relationship of one's own MI to the design of CBTs are non-existent. While Long and Smith (2004) stressed the need for incorporating MI into CBTs to provide different learning paths, the current study evaluates the relationship or associations between MI and CBT design.

In the long run, it is hoped that designers will be encouraged to stretch their own intellectual proclivities to design and create CBTs using effective MI strategies that are not necessarily of their own MI. There is a need for instructional designers and students learning to develop CBTs to understand not only learners' intelligences, but also their own MI predisposition, or the propensities of their own intelligence, because they may tend to design using only their own strongest intelligences when they develop CBTs.

Achievement-Enhanced Learning for All

In sum, the information gathered in this study will contribute to the body of knowledge related to MI and CBT design. Most important, there is a need to explore the use of the MI Theory to see if there is a correlation between developers' MI and how he or she designs a CBT. Results are relevant to individual/small instructional design teams of CBT designers/developers, to anyone teaching classes in multimedia technology programs by providing guidance in choosing a more effective educational CBT, and to those who teach in K-12 programs.

CHAPTER 2

Review of the Literature

This chapter provides a review of the literature on MI, instructional design, and CBTs. The eight MI will be examined individually, along with suggestions from the literature on how MI Theory can be incorporated into CBT design. The Multiple Intelligences Developmental Assessment Scale (MIDAS) and background from the literature on rubrics will also be reviewed.

Theoretical Framework: Historical Perspectives, Converging Technologies

Two major and almost simultaneous developments, both beginning in the 20th century, were examined as background for this study: (a) the invention and rise of educational computer technology, and (b) the development of the theory of MI.

Computers as Educational Tools

The hottest issue with regard to CBT in education, business, and information systems is how it is influencing the movement toward an optimal learner-centered classroom (Hill, Reeves, Wang, Han, & Mobley, 2003). The Web, with its dynamic new technologies and techniques emerging like digital weeds at a dazzling speed, has captured the interests of educators simultaneously around the globe. Because of these rapid changes, the face of education has also changed and so, to a certain extent, have people’s expectations.

Hirumi (2002) has urged instructional designers and educators to design student-centered, technology-rich learning environments to meet the needs of an information-based, technology-driven society because the traditional, teacher-centered modes of instruction are inadequate. Hirumi, along with other researchers, clearly believes that use of a simple textbook is no longer enough for an adequate education (Okamoto, Cristea, & Kayama, 2001). Today, there is an increased opportunity for individual engagement in interactive components that captures individuals interest better than only reading a textbook (Gilley, 2001).

School is a different place from what it was even 50 years ago. Education in the last century consisted of students attending local schools to receive group-based, face-to-face instruction. Students also memorized lists of facts, learned through lectures, and worked on separate skills, a state of affairs that Strickland and Strickland (1998) believe has contributed to undermining excellence in education. Today, by way of contrast, the individual can be in one place and the teacher, peers, and resources in another. The social dynamics of school have been reversed through bringing school to the individuals. Education is always accessible to individuals via the Web to learn at their own pace. Because there are no class time constraints, lessons can be repeated.

In sum, our educational world is being forged with communication systems that are re-shaping how we learn. We are in a new educational landscape. The new educational landscape will be an optimal learner-centered environment where there are no boundaries, only bridges that can be built. As we build these bridges, the construction will be bolstered on a footer grounded with a synthesis of empirical-based literature review and research.

Development of CBTs and Educational Theory

CBTs have been around for a long time, since the start of correspondence courses and since the first CBT, a training simulation, used by the air defense for an early-warning method (Long & Smith, 2004). In more recent years, use of CBT has been ignited because both the Internet and CBTs are resources that enable universities and businesses with opportunities to provide training with Web-based distance learning (Long & Smith, 2004). This latter concept is a combination of CBT and distance learning; and all of these approaches have the potential to enhance, rather than to replace, traditional classroom teaching (Tao, Guo, & Lu, 2006).

The second major development in education providing background for this research is the theory of MI. Since extensive research with brain-damaged patients, Dr. Gardner found that the brain seems to be divided into individual modules with different forms of symbols (such as pics or logical patterns) used by different regions of the brain (Burke, 1998; Gardner, 1993). Consequently, thanks largely to Dr. Gardner's work, MI is more than just a buzzword in education, and it is making a great impact. Heyworth (2002) believes that there is a great deal of promise in the digital highway, as various media technologies have the potential for combining a large number of the intelligences and thus enhancing learning.

Multiple Intelligences (MI) Theory

Throughout history, one’s intelligence has been measured with IQ and standardized tests by most educators, scientists, and educational institutions emphasizing math and language intelligence. However, Dr. Gardner’s (1983) theory of intelligences in his book *Frames of Mind* has greatly increased our understanding of intelligence (Appendix N). The MI Theory affirms that there are eight MI levels (see definitions in Appendix P), commonly referred to as musical, kinesthetic, mathematical, spatial, linguistic, interpersonal, intrapersonal, and naturalistic (Gardner, 1993). Eisner (2004) noted that Gardner’s MI Theory provides a radically different model for understanding how people think and further says that thinking in terms of MI is an effort to reframe our concept of intelligence (Eisner, 2004). Gardner believed that each person possesses all eight intelligences; most people can develop each intelligence to an adequate level of competency; intelligences usually work together in complex ways; and there are many ways to be intelligent within each category.

For real achievement, several of the intelligences need to be integrated (Heyworth, 2002) with multiple intelligences, because *one size does not fit all* (Eisner, 2004). However, Armstrong observed that Gardner adamantly maintained that, globally, education has historically focused on the linguistic and mathematical intelligences (as cited in King, 2000). When the other intelligences are ignored in education—those relating to art, music, athletic, as well as those relating to personal values, such as knowledge of one's self and of others—Gardner was quite right when he called education of this nature half- brain dead (as cited in Woods, 2004).

King (2000) built on these concepts when she observed that children gifted with musical or naturalistic intelligence would have difficulty learning if only the linguistic and mathematical intelligences are used to teach them. Such children, King contends, will strongly benefit from lessons structured to appeal to other types of intelligence. Woods (2000) agrees with King, noting that one individual may learn very differently from the next. It is only logical, as Dome (2004) points out, that if schools continue to teach primarily to mathematical and linguistic intelligences, individuals who learn in other ways are much more likely to fail. Veenema and Gardner (1996) take Dome's idea a step further and assert that such traditional approaches will benefit only individuals who are strong in these traditionally valued intelligences.

The MI Theory results in effective lessons. For example, Sweeney (1998) implemented MI Theory in grades kindergarten through fifth grade and made adaptations to the curriculum to meet their needs, resulting in not only a significant reduction in discipline problems but also an increase in learning (Sweeney, 1998).

Other researchers have noted the positive effects and significance of integrating MI Theory in class. Different Ways of Knowing (DWoK), by the Galef Institute, noted that when the MI were taken into account, positive effects were seen in individual achievement in 500 classrooms field-tested over four years. Specifically, language showed the strongest gains, math and reading improved, and social studies students scored higher as compared to students who did not use DWoK (Beauregard, 1998).

Shore's (2001) findings suggest that students have higher levels in self-efficacy when their own learning styles, cultural backgrounds, and MI-based lessons are incorporated into lessons which could aid in the success of English language learning. Therefore, integrating MI into English language learning lessons will affect self-efficacy, an increased feeling of capability that can increase the likelihood of success. Shore’s analysis revealed a highly significant positive correlation between mathematical and interpersonal MI with reading self-efficacy; a strong positive correlation between interpersonal, intrapersonal, linguistic, and bodily-kinesthetic intelligence with writing self-efficacy; and a positive correlation between speaking self-efficacy and interpersonal and visual-spatial intelligence. These findings all lend more support for the use of MI Theory-based lessons.

Having examined the literature showing that the concept of MI is highly useful for enhancing learning, we must now turn to the literature on how to start building the bridge between the concept of MI integrated into instructional design.

Instructional Design (ID) Theory

Theories on ID proliferate, and though the experts agree that a large number of theories exist, they also agree that there is little in the way of consensus about what makes an ID theory effective. Willis and Wright (2000) observed an excessive number of ID theories, but very little empirical research has been done to help designers make choices for effective design; and Merrill (2002) agrees, noting a plethora of ID theories and models in the past few years. Jonassen (2006a) also agrees that there are more than 100 theories of learning, but the truth is that each theory, like the next, is just a theory with no ability to predict how learners will construct knowledge. However, designers can be selective and choose appropriate theories for the design (Karagiorgi & Symeou, 2005).

In order for the construction of learning to start, according to Jonassen’s (2006a) theory of learning as construction, designers clearly need models as tools so they can choose from well known design models for instructional design: for example, the Dick and Carey model, ASSURE model, the ADDIE model, and many more. It is also clear, from Jonassen's (2006b) perspective, that neither any theory on learning nor any model for instruction can be regarded as best, even though Wilson (1995) stressed that instructional designers and teachers need models as tools for instructional design to adapt a model to a situation.

On at least one point, some consensus can be found: the role of the teacher should move from that of instructor/lecturer to that of facilitator (Wilcox & Wojnar, 2000). This is a constructivist model that guides the learner to search rather than using common instructional practices to tell and to direct. The goals of the constructivist model are to move from the sit-and-get approach, wherein students are passive recipients of wisdom received, to a go-and-get approach to learning. Wojnar (2000) explains that a constructivist approach results in a learner-centered design that empowers learners and guides them to search rather than using common instructional practices that tell and direct. However, the role of the instructors is not lessened. Constructivists believe learning is not a unidirectional procedure in which teachers inject knowledge into passive learners (Brahler & Johnson, 2001). Constructivist teachers put emphasis on learner collaboration (Wojnar, 2000). In addition, to creating a collaborative learning environment, there are more meaningful learning outcomes and more design flexibility for activities (Karagiorgi & Symeou, 2005). Thus, learners are becoming more engaged and active in their own learning (Boettcher, 2007).

An ID model, designed by Van Merrienboer, is perhaps the most wide-ranging of those in existence, as it encompasses all parts of the instructional process and focuses on problem-solving (Merrill, 2002). Teaching more independent problem-solving is just one advantage of using some constructivism in the instructional design, according to Karagiorgi & Symeou (2005). In accord with his skepticism about theory, Jonassen (2006a) noted that constructivism was neither a theory of learning nor a model to design instruction. But it can provide useful direction for a designer, because as Hannafin, Hill, and Land (1997) have noted, the sheer amount of information in modern times grows too rapidly to accommodate directed instruction, and some guidance is needed.

Wilson (2005) believes that the best learning occurs when teachers and students advance beyond theories of learning and focus on what makes learning a memorable and unforgettable experience. Wilson's theory can be congruent with other learning theories like Brunner's (1964) hierarchy of learning theory, in which information must be encoded in a memory that is meaningful, using multimedia (as cited in Wilson, 2004). Again, this is another example that points to multimedia as a way to implement MI Theory. These theories regard instructional design as a global effort for collaborating and sharing ideas. No matter how many theories there are to choose from, according to Tracey (2001), instructional designers still need to use instructional strategies to adapt to the learners needs so that students will take charge of their own learning.

The Instructional Design (ID) Process

According to Grabinger (2007), instructional design (ID) models consist of a process with phases to use 1) when designing CBTs in order to meet learners needs and 2) to help communicate with clients to determine project goals, learner outcomes, timelines, and budgets. Moreover, as indicated by Song, Hannafin, & Hill (2007), an effective learning environment is a shared teaching-learning process with the design aligned between the students' needs and the instructor's beliefs and practices. Because, as Jonassen (2006a) argues, people differ in their ways of knowing, it is possible that, if materials are designed based on MI Theory, different paths of learning can be provided to accommodate learners needs (Long & Smith, 2004). Teele (as cited in Dome, 2004) advocates a complete redesign of the entire education process with the goal of success for every student; and Dome also believes that the ability to design CBTs adequate to meet requirements of every individual will require a revamping of the ID process.

According to Koller, Frankenfield, and Sarley (2000), many educational multimedia products rely heavily on technological wizardry to impress learners while ignoring sound instructional design. These authors show that the instructional design process includes a needs assessment, goals and scope, audience analysis, learning objectives, appropriate instructional strategies, an assessment plan, and formative and summative evaluations.

Numerous approaches for integrating ID into the CBT design are discussed in this literature review, but the first thing one needs to remember is that the Instructional Systems Design is a process of reflection (Tracey, 2001). This is further substantiated by Koszalka, Grabowski, & McCarthy (2003) who claim that reflection strategies can help one to think through this process of designing because there are no quick fixes. Jonassen and Rohrer-Murphy (1999) also observe that all ID projects require adjustment during development.

Phases of Instructional Design

Siemens (2002) pointed out that the ADDIE Model is the most common instructional design model that derives its name from its five phases: 1) Analyze - analyze learner characteristics, task to be learned, etc.; 2) Design - develop learning objectives, choose an instructional approach; 3) Develop - create instructional or training materials; 4) Implement - deliver or distribute the instructional materials; and 5) Evaluate - make sure the materials achieved the desired goals. He further notes that some other useful current instructional design models are the Dick/Carey Model, the Smith/Ragan Model, and the Morrison/Ross/Kemp Model, which are all variations of the ADDIE model.

Most developers follow this design process with five phases: analysis-outline, high-level detailed design, storyboard development, production/programming-authoring, and quality assurance (Oakes, 1997). However, another company's education and training department has used this five-phase process: analysis, design, development, implementation and follow-up evaluation (Ziagos, 1996).

If an instructional design team is developing a course in a CBT, it might use the course development cycle; the five-phase process as outlined by Oakes above. Shih and Alessi's (1993) study reports a positive relationship between mental models and transfer ability, so they recommend instructional design models with conceptual models to teach cognitive skills, such as computer simulations, because learning and transfer of knowledge of cognitive skills is facilitated by using conceptual models.

Instead of a traditional instructional design, Grabinger (2007) advocates that the team uses a different approach, a sociocultural instructional design, which also provides an environment for adult learners. According to Grabinger (2007), the goal is to develop critical thinking, problem solving, research, and lifelong learning with an emphasis on collaborating with others and learning from experience so that learners are empowered with an equal responsibility for managing their own learning.

Fowler (2001) showed how important it is to identify the ways in which adults learn differently from those who are younger; by extension, we can conclude that these adult ways of learning involve the MI—a vital concept for any team that develops CBTs for adult learning to be aware of. Compelling evidence was uncovered regarding the needs of adult learners in a community college after the students and faculty completed the MIDAS survey to show their MI profiles (Malm, 2001). Specifically, the results of

Malm's (2001) study indicated that all of the intelligences were present in every group, but that adults MI with interpersonal and intrapersonal intelligences were the highest, and musical and naturalistic were the lowest. Statistically significant differences were found between the multiple intelligences of the groups in musical, linguistic, intrapersonal and naturalistic, and statistically significant differences were found between genders in mathematical, spatial, interpersonal and intrapersonal. The comparison group had higher scores in interpersonal and intrapersonal and lower scores in naturalistic and kinesthetic intelligences. Malm's findings would seem to support a suggestion from Sharma and Hannafin (2004), who say that a prerequisite to selecting effective learning tools and strategies for adults is to understand their learning styles. Malm (2001) concluded that community college teachers could greatly benefit from learning about MI and how they apply to the adult population due to the high scores in interpersonal and intrapersonal; thus, teaching strategies need to be developed and additional research done for this population.

Instructional Design Teams

Having examined the literature on MI Theory, one can see that this theory can provide CBT developers with an imaginative and creative way to approach designing instructional software. Obviously, incorporating the eight intelligences would give an advantage in terms of the educational value of the software.

Though it may be difficult to decide exactly what ID theory would work best, Hailey and Hailey (2000) observed that much time is needed to develop CBTs, so changes cannot be made overnight. The best place to start with trying to incorporate ID into CBTs is with an instructional design team process. More specifically, this team is needed to design CBTs utilizing an instructional design process. Ironically, this process engages MI itself.

Various recommendations have been made concerning this team. Willis and Wright (2000) recommend organizing a small core participatory team of two or three people, then involving various people at different points in the process. As Alessi and Trollip (2001) point out, designing multimedia for instruction is usually a collaborative effort that requires assembling a team of experts in various fields. Though some theorists prefer a team approach, it is important to note that Jonassen and Rohrer-Murphy (1999) indicate that either a lone designer or a team of assembled experts can work equally well.

Wilson (1995), however, is convincing when he emphasizes that the nature of the design team is extremely important, and he strongly advocates involving those who will be using the product—teachers and students, for example—in the design. He calls this the participatory design, a method that moves from the lab to the field. In essence, this technique will make possible a collaborative effort with the focus on the needs of both users and learners.

An example of a team effort was at Lehigh Valley Hospital that chose Dick & Carey's Instructional Systems Design (ISD) model for their hospital's instructional plan. First, their team was modeled after the Faculty and Instructional Development Group at Virginia Commonwealth University/Medical College of Virginia, but adaptations and modifications were made to fit their needs, and thus the Office of Educational Technology, a unit within the Center for Educational Development and Support at Lehigh Valley Hospital, was formed. At first, the faculty members and students were reluctant and wary to use a CBT to replace lectures; however, they were able to overcome the anxiety and promoted the use of technology to deliver medical education and self-study via a CBT (Koller, Frankenfield & Sarley, 2000).

Integrating Sound ID into CBT Design

Three Instruction Needs

Many of the main issues, discussed in the literature, were related to three CBT design needs: (a) accommodations, (b) assessment, and (c) technology tools.

Accommodations

The first main issue is the need to make accommodations for individual differences when using CBTs. In order to make accommodations, one needs to design multi-modally, meaning to identify multiple methods or alternative approaches to tap the potential of students. Reeves (2002) points out that one cannot assume that existing Computer-Based Education (CBE) necessarily addresses individual differences among learners, even though the use of CBE is often touted as advantageous for doing that very thing. Reeves further points out a huge difference in CBEs: whereas some have very little, if any, provision made for individual differences, others are designed to accommodate a wide range of individual differences. In addition, there is also a need to make accommodations by responding to individual strengths vs. individual deficits (Campbell & Campbell, 1999).

Mitchell and Kernodle (2004) are validating the need to discover their students' MI profiles in order to use instructional strategies and a variety of activities that match the strengths of each individual by enhancing their different intelligences. Reis, Neu, and McGuire (1997) also validate the need to use multiple instructional strategies in order to provide an opportunity for success for talented students with a high-ability or a high IQ and with learning disabilities, but who are not identified as gifted.

An innovative solution for accommodating many learning preferences is to use multimedia technology to implement MI. The use of multimedia technology will assist schools in reinventing themselves to provide an effective learning environment in which one can access educational resources from the convenience of one's home. Many educational environments offer integrated education, but they are seeking even more activities that nurture it (Heyworth, 2002).

Significant evidence from McDonald's (1999-2000) article supports this line of reasoning—that the user is provided with multi-sensory inputs through an interactive system. McDonald concurs that the multimedia learning system was effective when used for classroom-based instruction. He substantiates his research based on the U.S. Department of Education report, *A Nation at Risk,* and the Hudson Institute's *Workforce 2000*.

Noteworthy also is the empirical research by Monica Walch Tracey (2001) concerning the value of integrating MI into ID. The MI Design Model by Tracey presents instructional material to learners by incorporating multiple intelligences into the Instructional Systems Design (Tracey, 2001).

Assessment

The second predominant issue is the need for assessment of CBTs and alternative assessments for learning. These alternative assessments address the issue that *no one way is best for all* and provide an opportunity for each student (White-Taylor, 1998). This line of reasoning with regard to the need to build more realistic and authentic items with interactive computer-based assessment, instead of with paper-and-pencil multiple choice assessment, is convincingly supported with significant evidence from an article by French and Godwin (1996), who present the idea that interactive computer simulations and a hands-on performance evaluation could provide an alternative assessment to understanding human cognition. Another form of assessment is the use of concept maps (Clariana, Koul, & Salehi, 2006). Concepts, or mental representations, are the building blocks needed to communicate and to construct concept maps, maps of understanding that are actually spatial representations of a pattern or interrelationships of concepts (Jonassen, 2006).

Burke (1998) investigated the relationship between the MI proclivities of preservice teachers and their computer-based concept mapping. Specifically, he examined the complexity in their computer-based concept maps, and this was compared to their MI tendencies. Burke also looked at the relationship between the subjects' knowledge and their MI profiles, which were obtained using the MIDAS instrument. The findings showed a significant correlation between the subjects' strengths in MI and their success in concept mapping. From this research, Burke concluded that a teacher can increase his or her understanding of individual cognition by discovering their MI profiles.

Another form of assessment is implemented at Arts PROPEL, an acronym for Production, Perception, Reflection and Learning, which developed a model of assessment assuming that standardized tests are inadequate for assessing the arts (Simmons, 2001). In fact, Simmons noted research reporting that the use of MI-based, arts-infused curricula can help foster academic skills.

Hooper (2008) is designing software to be used as an assessment tool for the American Sign Language (ASL) program so a web camera, a capture tool can record a students performance, give instructor feedback and create a portfolio environment where students can keep their progress records.

Technology Tools - Benefits of Multimedia

The third predominant issue is the need to create technology tools because of the benefits. One important benefit of using interactive multimedia is that doing so improves the training and enhances the instruction (Bitter & Hatfield, 1994). Boettcher found benefits, such as pupil engagement and appeal to more of the senses, in the use of multimedia (as cited in Woods, 2004) and characterizes audiovisual use as very effective. Tiene has also emphasized that there is a bright future ahead to use digitized multimedia lessons (as cited in Woods, 2004). Scholars Khan and Gardner both validated the point that it is not necessary to have all multimedia elements (video, audio, graphics and animation) in every lesson, but using an appropriate amount of rich multimedia components does enhance learning with multiple intelligences (as cited in Woods, 2004).

Multimedia CBT authoring packages offer ideal ways to deal with MI; in fact, multimedia can be considered an implementation of MI because of its natural use of audio, video, etc. When multimedia is integrated, it has a profound impact on retention because it is enjoyable and engaging, and in this way it increases learning (Wilson, 2005).

Dunsworth and Atkinson (2007) found that learning can be fostered when a picture with narration is used rather than on-screen text, and the effect is even better with the use of animated agents with life-like behaviors that are programmed to coordinate the narration with gaze and pointing in a science computer-based multimedia learning environment.

Another tool that benefits computer-based learning environments is Pedagogical Agents as Learning Companions (PALs), animated peer-like characters that can simulate peer interaction in computer-based learning. Kim & Baylor (2006) suggest designing a PAL-based environment because it also calls for social interaction. Their study revealed that students in a voice-plus-agent environment outperformed those in both text-only environment and voice-only environment, with a significant positive impact on recall and enhanced self-efficacy.

It is increasingly popular to use animation as a learning tool in CBE (Schnotz & Rasch, 2005). A benefit of designing Computer-Based Instruction with graphics and animation is that it will stimulate mental models for a person's understanding of the environment (Shih & Alessi, 1993). However, King (2000) encourages designers not to use a lot of text but to use appropriate, simple animation. But designers need to be cautious not to emphasize the coolest animation or sound effects (King, 2000). Schnotz and Rasch (2005) also emphasized using animation with caution, because although it is beneficial, it can actually hinder learners who need less help.

Gilley (2001) has cited the critical findings from a study by Rieber that showed significant improvement in the performance of students who were given animation with a narration. Researchers Zhu and Grabowski (2006) emphasized the use of text and visuals or animations side by side with verbal and visual information because they studied and compared the use of Web-based animation and static graphics. They found that students who had a low prior knowledge were helped, but also that those with a high prior knowledge, though they performed equally well, did not experience much improvement (Zhu & Grabowski, 2006). A possible explanation, as noted by Schnotz and Rasch (2005), might be that animation could hinder learners who need less help.

Besides animation, video has a lot to offer. Steffey (2001) showed that the most effective way to maintain learner attention is to provide video in small components. Heyworth (2002) posits that video has a great deal of potential as a learning tool because it appeals to so many MI. Montazemi (2006) also provides compelling evidence to substantiate the claim that a learning environment with video *added to text* is another technology tool that is useful. Her study results showed a significant positive effect on the students intrinsic motivation and satisfaction when they learned with video. However, she found that adding video to text *and pictures* did not produce significant gains (Montazemi, 2006).

Besides video, the web has a lot to offer with a Web-based software technology tool, the Video Analysis Tool (VAT) system, can assess performance and aid in understanding the construction of knowledge (Hannafin, Hannafin, & Recesso, 2008). Dr. Michael J. Hannafin, Dr. Arthur Recesso, and Mr. Vineet Khosla developed the Video Analysis Tool (VAT), and the U.S. Department of Education’s Preparing Tomorrow’s Teachers to use Technology (PT3) funded it. VAT, used for continuous improvement of performance, has lenses that capture, analyze, and communicate findings to understand one's performance. The raters set up a video-capture device in the classroom to capture events, and then the rater uploads the video to VAT through its own Web interface and a special Internet Protocol (IP) camera. According to the rater's request, the video capture transfers the data to a mass storage on campus and then makes and uploads the video through a Web-based interface to VAT.

Though many studies have noted the positive results of using technology tools to create multimedia, Wendt (2001) found no significant difference between traditional class instruction and using CBT. Salinas (2001) also found no significant differences in learning via CBT versus class instruction. These findings from Wendt (2001) and Salinas (2001), however, may not take into account existing design strategies that are now being advocated. Hilts (2000), for example, has highlighted CBTs ability to add live action, such as interactive, Web-based chat rooms, live sessions to ask an expert, and simulated adaptive testing so the user is not isolated and can talk with others.

Still and all, higher education is looking more towards using technology tools for virtual learning environments as a means to supplement or replace traditional face-to-face instruction (Richardson, 2001). When designed by collaborative groups, software continues to improve in its ability to engage learners and to provide realistic and stimulating learning environments (Dymcock & Hobson, 1998, as cited in Richardson, 2001; Price, 1991). However, use of technology tools and even of computer-assisted materials needs to be based on sound pedagogical foundations.

A long journey through the educational theories reinforces this need. Borras (1998) asserts that research has not addressed ways to combine tools with the teaching/learning process. Research has been done on the effectiveness of technology-enhanced instruments primarily on either the teaching/learning process or the design of tools for instruction. However, there is a gap between how to use these tools with the speed of development (Iiyoshi, Hannafin, & Wang, 2005).

Gardner advocates using a variety of methods to reach and to develop all of the intelligences, particularly in early-childhood instruction (Ashmore, 2003). MI are not a faddish label, according to Kornhaber (2004), but are dynamic concepts that should spur educators to develop their teaching practices for more positive outcomes. Kornhaber conducted research over a ten-year period on MI with data collected from 41 diverse schools that used MI for at least three years, ten of these schools having received external awards for excellence. The findings included positive outcomes reported from the schools, improvements in standardized test scores, improvements in individual behavior, increased parent participation and a range of improvements for individuals with learning disabilities (Kornhaber, 2004).

Gardner's (1993), Veenema and Gardner's (1996), and Kornhaber's (2004) findings suggest that technology and multiple intelligences can be used as the means to enhance learning for a larger numbers of individuals with a variety of intellectual styles. For instance, the results from the Teele Inventory of Multiple Intelligences (TIMI) revealed that fourth grade students had an increase in intelligences, specifically in both spatial and interpersonal intelligences. The results also revealed a decrease in the two traditional intelligence types, linguistic and logical-mathematical (Ozdemir, Guneysu, & Tekkaya, 2006). These findings validate using MI strategies and integrating MI into instruction because there was a significantly greater achievement and a long-term retention of knowledge as compared to the traditional instruction for fourth graders on a unit. Also, the results indicated that the students, who were given instruction using the multiple intelligences, started to use other types of intelligences such as spatial, musical, and interpersonal intelligences, which are not emphasized in traditional instruction. In their control group after treatment, there was a decrease in spatial and interpersonal and an increase in logical-mathematical and bodily-kinesthetic, but according to Ozdemir, Guneysu, and Tekkaya (2006), no change was found in linguistic, musical and intrapersonal; these findings support the idea that traditional methods do not improve non-traditional intelligences.

Consequently, MI can be used as a tool to promote high quality student work rather than using the theory as an end in itself (Smith, 2002). Research by Kornhaber (2004), with the Project SUMIT (Schools Using Multiple Intelligences Theory), reported that the use of MI Theory in schools produced significant gains in SAT scores, parental participation, and discipline while the schools themselves attribute the gains to the use of the MI Theory. This theory represents a superior strategy for the preparation of CBTs.

More individuals can be reached by integrating information from different areas of the curriculum in a variety of ways (King, 2000). These conclusions have inspired the need to specifically integrate MI into CBT to enhance student learning. Significant evidence from Howard Gardner's MI Theory supports this line of reasoning. Building on this theory, multiple intelligences should be an integral component in the design of CBTs.

Wassermann also (2001) advocates use of software to enhance curricula because she had developed them in British Columbia, where the individuals indicated that their understanding had increased. Use of such media can help with incorporating all the intelligences so that individuals are encouraged to reach their full potential (King, 2000).

In order to improve the design of CBTs, knowledge and awareness of MI need to be integrated into the process. With this in mind, we now turn to findings from the research on integrating each of the eight intelligences as identified by Gardner (1993).

Musical intelligence.

Integrating musical intelligence with technology tools is critical for children's education because music is extremely important to children developmentally (King, 2000). Individuals gifted in music can benefit with music integrated in a lesson; for example, sing the alphabet song when teaching the alphabet, instead of having the child memorize it verbally (King, 2000). King created a CD-ROM multimedia musical tool, titled *A Garden Symphony,* for ages 6-10 to provide an environment so they can think creatively about a musical composition which was based on research of interface design, music in multimedia, MI Theory and user testing.

Leslie Fanelli (1998) is founder and artistic director of the Theatre in Motion, an education theatre company mainly for grades K-8. Ms. Fanelli employs MI with hands-on participatory creative drama activities. Fanelli noted one activity, with a rainbow song, that revs up and taps all eight intelligences simultaneously.

A study investigating the relationship between academic achievement and MI learning styles showed that the strongest intelligence for female high school students was the musical intelligence (Snyder, 2000). The findings indicate that kindergarteners, ages 5-7, should have curriculum designed with musical intelligence.

Ashmore (2003) also noted results from several more studies: Acuff shows that preschool-age children are primarily musical (as cited in Ashmore, 2003). According to Shearer's 2002 MIDAS_KIDS, kindergartners showed that their musical intelligence was medium, and Teel's 1994 TIMI, an MI inventory, showed musical intelligence as the strongest intelligence for high school students (as cited in Ashmore, 2003). Shearer's 2002 MIDAS provides further evidence that one of the three highest intelligence types was musical in high school students (as cited in Ashmore, 2003). Sanders (2002) has gone so far as to say that those who learn musically do not benefit from material that does not include music, even if other forms of media are involved; and Ashmore notes that if music is included in CBT design, the lessons will help those who are gifted with musical intelligence.

Verbal-linguistic intelligence.

Integrating verbal-linguistic intelligence with technology tools, such as a grammar checker, is worthwhile for instructing individuals on its use simply to check, not to write in order to get their job done (Rieber, 1992).

Linguistic was the strongest intelligence for female students in Snyder's (2002) study on the relationship between academic achievement and MI learning styles. Ashmore (2003) noted results from several more studies: kindergartners, ages 5-7, showed that one of their strongest intelligences was linguistic, as shown in Teele's 1994 TIMI, an MI inventory; however, just the opposite has also been found, showing that one of kindergarteners' lowest intelligence is linguistic in Shearer's 2002 MIDAS_KIDS; but linguistic was found to be one of the four highest intelligences for high school kids in Shearer's 2002 MIDAS.

Logical-mathematical intelligence.

Sanders (2002) believed that for learners with logical-mathematical intelligence, multimedia approaches were beneficial because such learners do well with solving problems using logical concepts. Collis, Obserg, and Sherra found in their research that individuals attitudes and skills improved as a result of Computer-Based Instruction in statistics, and Gokhale found that student performance increased as a result of integrating computer-aided instruction with computer simulation in a traditional lecture lab (as cited in Sanders, 2002).

For individuals who prefer to learn in a different way, Wills & Johnson (2001) cite some meaningful examples of integrating MI instructional strategies in math. Children can use their mathematical intelligence and show they understand mathematical concepts through a variety of activities, such as singing the multiplication tables quietly to themselves, tapping a pencil in rhythmic patterns to solve a problem, sorting crayons into groups to help themselves find an answer, or checking their discoveries with friends (Wills & Johnson, 2001).

Chisholm's (1998) findings indicated gender differences in math, with males' scores much higher than females' in logical-mathematical intelligence; in addition, males scored higher at every grade level. This does not necessarily mean that girls do not have the same capacity. In Snyder's (2000) study on the relationship between academic achievement and MI learning styles, logical-mathematical intelligence was the most dominant intelligence for male high school students.

Shearer's results from 2002 with his MIDAS_KIDS showed that logical-mathematical intelligence was the lowest one for kindergartners (as cited in Ashmore, 2003), while the results from the Teele Inventory of Multiple Intelligences (TIMI) revealed that the logical-mathematical intelligence was the most dominant intelligence for fourth grade students, both before and after treatment (as cited in Ozdemir, Guneysu, & Tekkaya, 2006).

Bodily-kinesthetic intelligence.

Snyder's (2000) study revealed that for male high school individuals the most dominant intelligence was the bodily-kinesthetic intelligence. Ashmore (2003) noted results from several studies: bodily-kinesthetic intelligence is one of the four strongest intelligences for kindergartners, as shown by Teele's 1994 TIMI, and similar results from Shearer's 2002 MIDAS_KIDS showed bodily-kinesthetic to be one of kindergarteners' four medium intelligences.

Spatial intelligence.

Learning with non-redundant, integrated pictures with words is significantly more efficient than learning with pictures alone or text alone according to study results by Moreno and Valdez (2005). This study strongly supports the notion that individuals learn better when provided with visual *and* verbal materials rather than with visual *or* verbal materials alone (Moreno & Valdez, 2005). Interestingly, keyboarding involves three MI: it is a kinesthetic activity, a spatial activity, and an interpersonal activity (Hennigan, 2000).

The results of Snyder's (2000) study showed that male high school individuals were strong in spatial intelligence. The findings also indicate that kindergartners are strong in spatial intelligence, as also shown by Shearer, Teele, and Acuff (see below) (Ashmore, 2003). Web sites employing a variety of media—music, other sounds, graphics—are often appealing to individuals whose strongest intelligence is spatial (Ashmore).

Ashmore (2003) noted results from several more studies: Acuff indicated that preschool-age children possessed primarily spatial intelligence, and Teele's 1994 TIMI showed spatial intelligence as one of Kindergartners' four strongest intelligences. In Shearer's 2002 MIDAS_KIDS, spatial intelligence proved to be the highest one for kindergarteners. Teele showed spatial intelligence to be one of the four most dominant for high school individuals, and Shearer's 2002 MIDAS further substantiated this with almost identical results.

Interpersonal intelligence.

The results of Hooper's study of 138 sixth-grade individuals in cooperative learning groups while working at a computer indicated that individuals who had an average level of persistence interacted more than individuals who had either high or low persistence. This study supports the notion that individuals learn through their interpersonal intelligences when provided with a cooperative learning group. The findings from Snyder's (2000) study validate the use of interpersonal intelligence strategies as they showed that female high school individuals were strong in interpersonal intelligence.

Ashmore (2003) noted results from several more studies indicating that one of kindergarteners' four medium intelligences was interpersonal, as shown in Shearer's 2002 MIDAS_KIDS; high school individuals had interpersonal intelligence as one of their four most dominant intelligences, as shown in Teele's 1994 TIMI. Further evidence from Shearer's 2002 MIDAS indicated that interpersonal intelligence was one of the four most dominant for high school individuals.

A high interpersonal intelligence is not limited just to children. The highest intelligences of adult learners in a community college who completed the MIDAS survey were interpersonal and intrapersonal (Malm, 2001). In addition, Woods (2004) examined student ratings concerning Web-based instruction in relation to integrating instructional technologies, implementing the seven principles of good practice and accommodating diverse multiple intelligences. He made recommendations for designing courses to accommodate the needs of adults. Twenty individuals were enrolled in a Web-based course with Blackboard, Inc. The results showed a significant correlation of student satisfaction and Web-based technologies, principles of good practice, and MI/learning styles. Interpersonal and intrapersonal intelligence both received higher ratings than other intelligences did. Sanders (2002) observed that unless the multimedia approach is interactive, those strong in interpersonal intelligence do not benefit.

Intrapersonal intelligence.

As with interpersonal intelligence, results showed that intrapersonal intelligence was dominant for female high school individuals in Snyder’s (2000) study. Unlike those with interpersonal intelligence, however, individuals with a strong intrapersonal intelligence gain from a multimedia approach to lecture because they are good at analyzing the material and applying the knowledge in a practical way (Sanders, 2002). Woods (2004) made recommendations to design courses to accommodate the needs of adults because his results showed a significant correlation between student satisfaction and multiple intelligences/learning styles with intrapersonal intelligence receiving higher ratings.

Ashmore (2003) noted results from several more studies (specifically those of Shearer and Teele) indicating that kindergarteners, ages 5-7, showed similar profiles in regard to intrapersonal findings. For kindergartners, ages 5-7, one of the four strongest intelligences was intrapersonal (according to Teele's 1994 TIMI, an MI inventory), and intrapersonal was one of the four medium intelligences of kindergartners (in Shearer's MIDAS KIDS).

Naturalistic intelligence.

McKinnon & Geissinger (2002) examined how learning can be enhanced with naturalist activities. Specifically, they cite various space studies and scientific-grade telescopes; in Great Britain, individuals can use the online Bradford Robotic Telescope and software system; in the United States, individuals can access telescopes via the Internet and the Telescopes in Education (TIE) program with software and workbooks from The National Aeronautics and Space Administration (NASA); and in Australia, individuals can use a CD-ROM and computers with scientific equipment that responds to their commands in *A Journey through Space and Time*, sponsored by Charles Sturt University.

Dickinson (1998) writes that the new world of learning has no walls so that educators and students can collaborate with scientists to do naturalistic activities integrated into the classroom, such as viewing a live video (at http://www.edutopia.org/wetland-ecology-technology-video) where students use Learning Landscape to monitor the terrain with a new technology to study the ancient ecology of a vast prairie wetland.

Bridging Instruction to Learning—A Tool for Learning

Recommendations for Integrating MI into CBTs

What we have seen thus far from the literature is that people are smart in many different ways. The MI Theory teaches that all are smart, but that intelligence can manifest itself in eight different ways. Almost no one is strong in all intelligences. In MI

Theory, all intelligences are valued equally; no one intelligence is preferred over another. MI give us more ways to help individuals learn. In addition, the great power and ubiquity of computers has opened up new avenues in education; and computers in some ways naturally appeal to different intelligences.

Since CBTs are designed largely for self-directed learning, it is important to keep in mind that the MI Theory is a model and a tool that can be used to help more people grow and succeed. The CBTs can be designed to nurture and activate a neglected intelligence and to encourage the use of all intelligences. A person's weak intelligence could, with training, turn out to be his or her strongest intelligence. Most people can develop all their intelligences to a competent level of mastery. With MI, we are offered different ways to learn. Therefore, the design of a CBT can be designed to fit each learners needs.

Often we look for quick-fix solutions. However, successfully implementing MI is challenging because it requires much creativity, energy, and time. The ways MI Theory can be used are limited only by a person's creativity. The best beginning idea is to use a broad range of strategies. All CBTs could have multiple pathways to learning and may incorporate all intelligences. However, some CBTs will be designed to use a single intelligence.

Samples, Examples—MI Lessons

With knowledge of MI, we can modify design to use MI. There is no single path to implement MI—no one right way. The beauty is that instructional designers can use MI to create unique CBT content. Many instructional designers are taught to focus on design and development. However, MI offers a learner-centered model in which a CBT can be designed, modified, and developed to fit the learners. Gardner assures that MI will offer everybody a fair and just instrument to enable everyone success (Berkemeier, 2002). Therefore, transforming theory into real-life CBTs will open the door to using MI. Designers need to have knowledge of MI Theory so they can trust their judgment on how MI can best be used to meet the learners needs. Designers should ask themselves: to what degree am I bringing the different intelligences to life in this CBT?

It is beyond the scope of this study to contemplate ways in which MI can be used to help individuals learn, but designers should remember to oblige all MI (Synder, 2000); there is no perfect CBT, and success for all requires one to strive for a journey of excellence.

MI Design Model

The review of literature up to this point has focused primarily on MI Theory and ID Theory, but there is a need to bridge them to create CBTs using such solid educational theories. Searching through the literature has revealed a significant model from the work of Tracey (2001), who constructed an instructional systems design model incorporating multiple intelligences (see Appendix M). The purpose of this model is to help instructional designers to design instruction with the focus on differences in learners intelligences. It was stressed that designers need to know the learners' MI.

Incorporating MI Theory can have remarkable implications not only for end users but also for designers to aid them in creating well-rounded CBTs. Knowing the differences in one’s intelligence and how one learns can empower individuals or designers to apply the MI model in the CBT development process. The ideas in the model provide some useful concepts to understand both MI and CBT design and to create a learning environment to enhance learning.

Most of the MI design models use a five-phase approach; however, the MI Design Model here includes four instructional design stages: Analysis, Design, Develop and Evaluate. The analysis stage begins with an analysis of the learner, the environment, and the desired performance. Then the behavior characteristics identified are used to write behavioral objectives incorporating MI. Instructional strategies are then selected and created in the design stage. Tracey (2001) mentions that at least one strategy for each of the MI identified should be incorporated. This instructional design stage should be considered as the heart of the ID process to integrate MI into the design of a CBT. Then all materials are developed and evaluated. The MI Design Model can be used with any instructional design model that one is most comfortable using.

After a thorough review of the literature, there was a need to search the literature for an instrument to assess the intelligences of the individuals in this study.

Multiple Intelligences Developmental Assessment Scale (MIDAS)

The Multiple Intelligences Developmental Assessment Scale (MIDAS) is a survey instrument designed in 1987 by Dr. Charles Branton Shearer. It was designed to enhance cognitive functioning following brain trauma. However, the MIDAS test, a self-completion survey instrument with a 119-question Likert scale instrument will provide data for statistical analysis with descriptives. Out of the 119-questions, each of the eight MI components included the following number of questions: musical (14), kinesthetic (13), mathematical (17), spatial (15), linguistic (20), interpersonal (18), intrapersonal (9), and naturalistic (13).

The MIDAS survey is intended as a screening instrument to determine the characteristics of an individual's MI disposition. This assessment scale will provide profiles that give a reasonable estimate of one's intellectual disposition according to Gardner's eight intelligences. The profile provides percentage scores that indicate relative strength in "intellectual disposition" of each of the eight intelligences (Shearer, 1994-96). The test was created to provide information about an individual's intellectual development and/or to aid curriculum design for instructional strategies designed to enhance Gardner's multiple intelligences.

A reliable and valid instrument is needed for identifying a person's MI. Although various scholars have developed MI surveys, only one is listed in the *Mental Measurements Yearbook*. Therefore, this instrument, the MIDAS, will be used not only because it was listed in the *Mental Measurements Yearbook* but also because of its validity and reliability (Shearer, 1994).

After a thorough review of the literature for an instrument for this study, it became a task to review the literature on rubrics because there was a need to construct a rubric tool to conduct an effective evaluation/analysis of the students completed CBTs (Appendix O).

MI Rubric

Reeves (2002) has indicated how imperative it is to develop evaluations of Computer-Based Education (CBE) with accurate criteria; he stressed that we need *significant changes* in education, and, therefore, that improving evaluation of CBE has never been more important, perhaps because of the rate at which technology is advancing. In addition, the culture of our educational environment is changing, and the world seems to be getting smaller because we can get information instantly from around the globe (Koszalka, Grabowski, & McCarthy, 2003). The ready availability and power of relatively inexpensive modern computers has greatly popularized the use of CBE (McKethan and Everhart, 2001). McKethan and Everhart go on to point out that it would be wise to examine Computer-Aided Instruction (CAI) for its content as well as for its ID. In summary, it is imperative for educational researchers to develop criteria for evaluating CBE.

Ideas for the design of the MI Rubric came from the literature review information; however, it is important to note that an existing rubric for evaluating CBT design was not found in any of the literature. Although various scholars have developed rubrics and evaluation tools, the rubric design for this study was based on the research of Dr. C. Branton Shearer and his MIDAS instrument. It was imperative to use the most reliable and valid instrument available for constructing a tool to identify the integration of MI in a CBT, given the dearth of solid instruments for evaluating CBTs. In pursuit of this, a rubric tool was designed with criteria for evaluating the students CBTs for this study (Appendix O). This rubric provided the CBT reviewer ratings by four reviewers.

The purpose of this chapter was to derive information from a literature review that can be used as the basis to identify theories for multiple intelligences and instructional design. ID Theory and MI Theory can be merged into creating a CBT design to present new information with several intelligences. Designers that have an awareness of their own MI can be empowered to design with MI that match the strengths of learners. This is considered making accommodations to reach a greater number of learners.

CHAPTER 3

Methodology

This chapter addresses the following research question and corresponding hypothesis.

Research Question

For student CBT developers, what is the relationship between their MIDAS profiles and CBT reviewer ratings of MI used in the design?

Research Hypothesis

Student CBT developers will show a positive relationship between their MIDAS profiles and the corresponding CBT reviewer ratings.

Overall Summary of the Study Design and Methodology

To address the above research question, this study analyzed whether CBTs are created and designed based on a natural process of a designer's individual MI predisposition or the propensity of his or her own intelligences. The relationship of participants' MI predisposition with the CBT design was examined. One method included assessment of qualitative data from observations of the CBT features to help achieve the study objective.

To assess the research question, data were collected via a cross-sectional study of volunteer graduate students who were learning to design CBTs in a Multimedia program. Statistical analyses included: 1) descriptive statistics, 2) correlation coefficients, and 3) regression analysis.

Participants

The sample was recruited from 14 volunteer graduate students (seven male, seven female, ages 23-39), enrolled in an introductory Multimedia Technology course about Instructional Design at a university in Pennsylvania, who were novices learning to develop CBTs. In accordance with the University procedure, an application for approval of this research project containing human subjects was completed and approved by the Institutional Review Board (IRB). The approved consent letter, requesting participation in this study, was then given to the volunteer students to read and sign prior to participation. Any student who did want to participate had the opportunity to decline participation without penalty. Students were free to withdraw their consent at any time for any reason.

Procedure

The study was designed to last four months, beginning when the students were instructed to complete a survey entitled "The Multiple Intelligence Developmental Assessment Scale." After completing the survey, the students were given a CD-ROM containing two 1/2-hour videos on MI, which they were required to study at their leisure. In addition to the instructional videos, the course instructor provided a lesson on MI as well as instruction during the semester on CBT design and development. Over the 16-week course period, each student was assigned to develop a CBT program that integrated MI.

Data Collection Instruments

A rubric tool was designed to evaluate the CBTs for evidence of MI strategies integrated into the CBT program design. A pilot test of a prototype of the rubric instrument, based on Shearer's MIDAS instrument, was conducted with an educational school administrator/curriculum coordinator with a doctorate and with proficient knowledge of MI. The instrument was approved by an administrator, a leading expert in the field. A team of four reviewers, education researchers, who had knowledge of MI, used this rubric questionnaire, titled "Assessment Criteria Rubric." These four reviewers each evaluated each of the 14 CBT programs for evidence of each of the eight MI for strategies that integrated the MI into the CBT program (see Appendix O).

The "Average of Four Reviewers Ratings on the Rubrics for Students CBTs" was used by the four reviewers to score or quantify the extent to which each program design provided examples and showed evidence of MI strategies (see Appendix D). Then, the programs were rated using a 4-point Likert scale with the following responses: Significant Evidence (3), Good Evidence (2), Some Evidence (1) and No Evidence (0) (Appendix D). This final rating for each CBT program was calculated based on an average final score from each of the four reviewers (see Appendix C).

The participants completed "The MIDAS: Multiple Intelligence Developmental Assessment Scale" or the MIDAS survey. The MIDAS survey is an assessment to collect the best quality of information possible in order to obtain a detailed description of a person's multiple intelligences, including strengths and limitations. It consisted of 119-item self-reported, 30-minute questionnaire. These forms were scored (by Dr. Shearer) using a computerized software program, entered into the statistical package (SPSS), and checked for obvious errors.

The MIDAS profiles are a reasonable calculation or estimation of one's own MI or one's disposition of one's strengths and limitations in each of the eight constructs (Linguistic, Mathematical, Spatial, Musical, Kinesthetic, Interpersonal, Intrapersonal, and Naturalistic). The eight MIDAS profiles were then interpreted as follows: 0%-40% (were considered low scores), 40%-60% (were considered moderate scores), and 60%-100% (were considered high scores). In this study, the MIDAS profiles are the developers' MI scores from their MIDAS surveys. The MIDAS profiles are then calculated based on a five-point Likert scale that ranges from All the Time or Excellent (4) to Never or Very Little (0); any N/A responses were excluded from the calculation. An individual's total, across all Likert scale responses within a given component, was then divided by the total possible to determine the percentage score for that component.

The MIDAS profiles, received from Dr. Shearer, are the developers' MI scores from the MIDAS survey. These MIDAS profiles were one of the sources of the three collections of data for this study. Appendix B shows the raw scores of the MIDAS profiles of the 14 subjects in each of the eight constructs or MI, and Appendix C shows the raw scores of the CBT reviewer ratings, an average of the four reviewers.

Statistical Analysis of Quantitative Data: MIDAS Profiles and CBT Reviewer Ratings

The quantitative data were collected from two sources: 1) MIDAS profiles and the 2) CBT reviewer ratings. The MIDAS profiles are the developers' MI scores from the previously described MIDAS survey. The CBT reviewer ratings are the students' CBT design scores from the reviewer ratings on the previously described rubric. The variables are the CBT reviewer ratings, which serve as the outcome variables (y), and the MIDAS profiles, which serve as the predictor variables (x). The CBT reviewer ratings were compared to the MIDAS profiles using several methods.

Three types of statistical methods were performed: 1) descriptives, 2) correlations, and 3) regressions. First, the data were summarized with means, ranges, and standard deviations. Second, correlations were calculated between the MIDAS profiles and the CBT reviewer ratings. Third, regression analysis was also performed to further assess the magnitude and direction of the predictor variable's impact on the dependent variable. There was a separate regression model for each of the CBT reviewer ratings (dependent variables) that were regressed against each of the eight MIDAS profiles (independent variables) listed in the model, thus yielding a total of 64 different simple regression models. Multiple regression models were refitted to fit all MIDAS profiles with $p < 0.05$.

These specific statistics—correlation coefficients (r), coefficient of determination (R^2), the regression slope, and the significance of the F-Test (p-value)—were calculated to assess the relationship between the MIDAS profiles and CBT reviewer ratings (see Appendix P for specific definitions).

Statistical Analysis of Qualitative Data: CBT features

In addition to the two sources of quantitative data collected, data were collected from the third source, the CBT features. The CBT features, which represent qualitative reviews of the CBTs, were then specified as the (dependent) outcome (y) variables for additional regression analysis; the eight MIDAS profiles were again, the (independent) predictor (x) variables.

Correlations and regressions were again calculated as previously described. For the regression modeling, there was again a separate regression fit for each of the ten CBT features. The eight MIDAS profiles were again specified as the independent predictor variables, thus yielding a total of 80 simple regression models. The ten CBT features included: (1) text density, (2) program length, (3) media, (4) MI vocabulary, (5) MI instances, (6) instructional activities, (7) interactions, (8) number of program levels, (9) number of nodes (see Appendix P) at each level and overall and (10) navigation. The ratio of navigation links to nodes will also be assessed (see Appendix Q).

Program Feature Measures

The CBT programs were reviewed based on observations of the following measures.

Text Density

The number of words on each screen excluding text labels and menu item labels were tallied (see Appendix F).

Program Length

The total number of screens in each program was counted (see Appendix F).

Media

The total number of media elements including graphic buttons, graphics/images, sounds, videos, and animations/transitions on each screen were counted (Appendix G).

MI Vocabulary

Based on a review of MI literature, a vocabulary list was developed that included labels and/or short phrases reflective of MI. The list was used to identify MI vocabulary in the program content (see Appendix H). This time, independently, two reviewers randomly selected 7 out of the 14 CBT programs (half of the data was missing) and, using the vocabulary list, noted MI expressions on each screen. The reviewers compared their codes and reconciled differences with at least an 85% agreement to obtain inter-rater agreement for reliability.

MI Instances

Based on a review of MI literature and the rubric, a list of MI indicators was developed that included mathematical symbols, graphics, or images that reflected evidence of the MI used. These instances included those not previously identified with the MI vocabulary as well as instances one would surmise are indications of specific MI. For example, a screen presenting a photograph of a person caring for animals would be considered as a naturalistic MI. The list was used to identify instances of MI in program content. This time, independently, two reviewers randomly selected 7 out of the 14 CBT programs (half of the data was missing) and, using the list, noted MI instances on each screen. The reviewers compared their codes and reconciled differences with at least an 85% agreement to obtain inter-rater agreement for reliability (see Appendix H).

Pedagogical Feature Measures

Instructional Activities

Based on a review of the MI literature, a list of activity types was developed that matched or reflected the MI language used in the rubric (see Appendix O) and other literature sources. The list was used to identify activities of MI in program content. Independently, two reviewers for this task randomly selected 7 of the 14 CBT programs (half of the data was missing) and, using the list, noted MI activities. The reviewers compared their codes, and reconciled differences with at least an 85% agreement to obtain inter-rater agreement for reliability (see Appendix H).

Interactions

A total number of interactions on each screen that included the following types were counted (see Appendix I):

Click: Mouse clicks on each screen with the right answer counted.

Drag: Drag an item to the correct answer over a touch target/hot spot area.

Press: Keypress one's response/answers for multiple choice or true/false.

Feedback: When designer responded to quiz answers.

Response Tries Limit: Quiz questions limited to number of times to answer.

Response Time Limit: Time limit to respond to a question.

Text Entry: Fill in the blank answer.

Program Structure

Number of Program Levels

A program level enables user interactivity from level one, with minimal interactivity, to level two and so on with more in-depth information at the next level. The depth of one to eight levels was tallied (see Appendix J).

Number of Nodes at Each Level

All of the nodes at each level and depth of the navigation were counted (see Appendix J). A node can be a window or a message box on a computer screen with links to information to enable users to change the information on a screen (see Appendix P).

Number of Nodes Overall

All of the nodes, overall, were counted for the depth of the navigation. This ranged from 12 nodes on three levels up to 240 nodes on six levels (see Appendix J).

Navigation

Links are the (forward/down, horizontal and back/up) link buttons that enable the user to navigate on a computer screen. Appendix K shows the following buttons were counted:

Quit: Total number of buttons to quit.

Go Back to Previous Screen: Total number of buttons to go back to previous screen.

Quiz: Total number of quiz buttons.

On Screen: Total number of buttons in the On Screen Menu.

Pull Down Menus: Total number of buttons in the Pull Down Menu bar.

Continue or Forward Pacing: Total number of times counted on each screen with a continue button to move forward (ex. next)

Go Back to Main Menu: Total number of buttons to go back to the Main Menu.

Ratio of Navigation Links to Nodes

The depth of all of the navigation links were compared to the number of nodes at each level (see Appendix L).

In sum, both correlation and regression analysis were conducted to address the relationship between MIDAS profiles (of the student CBT developers) and their CBT reviewer ratings (of MI used in the design). First, using a self-designed rubric, the 14 CBT programs were rated for evidence of MI by four reviewers for this particular task.

Second, correlations and regressions were performed between CBT reviewer ratings and the developers' MIDAS profiles, as obtained from the MIDAS survey.

Qualitative data were also analyzed using both correlation and regression analysis to assess how the MIDAS profiles (the independent variables) were related to the CBT features (the dependent variables). More specifically, separate analyses were completed for each of the ten CBT features: (1) text density, (2) program length, (3) media, (4) MI vocabulary, (5) MI instances, (6) instructional activities, (7) interactions, (8) number of program levels, (9) number of nodes at each level and overall and (10) navigation. The ratio of navigation links to nodes will be assessed (see Appendix Q).

Altogether, the data were collected from a total of three data sources—1) MIDAS profiles, 2) CBT reviewer ratings, and the 3) CBT features—and were analyzed using three methods: 1) descriptives, 2) correlations, and 3) regressions.

CHAPTER 4

Results

In order to investigate the relationship between the MIDAS profiles and CBT reviewer ratings, data were collected from both the quantitative and qualitative data, as described in chapter 3. For future reference, the MIDAS profiles are the scores obtained from the MIDAS survey that indicates the self-reported intelligences of the student CBT developers. The CBT reviewer ratings are the average ratings of the four reviewers. This chapter presents results: (1) descriptive statistics, (2) correlations, and (3) linear regression models.

Statistical Analysis of Quantitative Data: MIDAS Profiles and CBT Reviewer Ratings—Descriptives

MIDAS Profiles --Quantitative

Table 1 shows the descriptive summaries of the MIDAS profiles of the students (raw data is listed in Appendix B). The eight MIDAS profiles were each interpreted as percentage scores that indicated relative strength in "intellectual disposition" as follows: 0-40 (low ability scores), 40-60 (moderately well-developed ability scores), and 60-100 (high scores). Therefore, the descriptive summaries (means, etc.) of the MIDAS profiles were also interpreted as percentages. The mean scores for the eight main scales range from a low of 44.7 (naturalistic) to a high of 62 (spatial) with a grand mean of 56. A high MI indicates a high intelligence by a student on the MIDAS profiles. With respect to this, the mean scores of the three highest intelligences from the students MIDAS profiles (in percentages) were spatial (62), interpersonal (60.3), and linguistic (59). The standard deviations (the spread of data indicating how far the data values are from the mean) were all in the range of 15 to 20. With the exception of one observation (of 7 for the Naturalistic component), the minimum scores range from 23 to 36. The maximum scores were all near 80 or 90.

Table 1 *MIDAS profiles for each MI. (N=14):*

Descriptive Summaries with Mean, Range, Standard Deviation, and Std. Error of Mean

MIDAS profiles	Mean of MIDAS (%)	Standard Deviation (%)	Minimum	Maximum	Range	Std. Error of Mean
Spatial	62	17.65	36	91	55	4.72
Interpersonal	60.3	17.28	28	93	65	4.62
Linguistic	59	19.51	25	87	62	5.22
Mathematical	57.6	17.33	33	93	60	4.63
Musical	54.41	20.40	14	83	69	5.45
Kinesthetic	54.36	18.20	27	86	59	4.86
Intrapersonal	54.1	14.60	23	79	56	3.9
Naturalistic	44.7	18.83	7	81	74	5.03

Key: 0-40 (Low scores); 40-60 (moderate scores); and 60-100 (high scores)

CBT Reviewer Ratings--Quantitative

Table 2 shows the descriptive analysis of the CBT reviewer ratings (see Appendix C for the raw data). Out of the eight components for the CBT reviewer ratings, three highest mean percentage scores were spatial (42.20), linguistic (39.50), and kinesthetic (27.11); the lowest was musical (8.3). The standard deviations ranged from 21.72 for kinesthetic MI to 7.94 for intrapersonal. Minimum scores were between 0 and 5 for most components, but as high as 19 and 22 for spatial and linguistic, respectively. The maximum scores also showed a wide range (from 37 to 78). Appendix E shows the descriptive analysis of the qualitative CBT features. The counts showed a wide range from 30, 855 (text density) to levels (levels).

Table 2 *CBT Reviewer Ratings for each MI. (N=14): Descriptives with Mean, Range, Standard Deviation, and Std. Error of Mean*

MI	Mean of CBT (%)	Standard Deviation (%)	Minimum	Maximum	Range	Std. Error of Mean
Spatial	42.20	12.26	19.40	58.30	38.90	3.28
Linguistic	39.50	8.93	21.60	53.30	31.70	2.34
Kinesthetic	27.11	21.72	2.70	77.70	75.00	5.80
Intrapersonal	21.40	7.94	5.00	36.60	31.60	2.12
Mathematical	21.30	12.50	1.50	41.60	40.10	3.34
Interpersonal	13.70	17.04	.00	50.00	50.00	4.55
Naturalistic	10.50	16.11	.00	47.20	47.20	4.30
Musical	8.30	12.36	.00	38.30	38.30	3.30

Correlation Analysis of MIDAS Profiles and CBT Reviewer Ratings

Table 3 shows the pair-wise correlations between the MIDAS profiles and CBT reviewer ratings for each combination of the eight MI components. The results indicated the vast majority of correlations were low to moderately/low values of $r < 0.40$ (with none above 0.44); all results were non-significant at $p > 0.05$, and most were non-significant at even the 0.10 level of significance (with 1-tailed tests).

Table 3 *Matrix of Correlation Coefficients: MIDAS Profiles and CBT Reviewer Ratings*

			MIDAS profiles							
			Music	Kinest	Math	Spatial	Ling	Interp	Intrap	Nature
CBT Reviewer ratings	Music	Corr.	.12	.12	.12	.32	.21	-.04	.25	-.01
		(p-value)	(.34)	(.34)	(.34)	(.13)	(.23)	(.44)	(.19)	(.49)
	Kines	Corr.	.03	.01	-.07	-.10	-.40	-.29	-.16	-.17
		(p-value)	(.47)	(.49)	(.41)	(.36)	(.08)	(.16)	(.30)	(.29)
	Math	Corr.	.23	.02	-.41	-.30	-.43	-.21	-.44	-.4
		(p-value)	(.22)	(.47)	(.07)	(.15)	(.06)	(.24)	(.06)	(.08)
	Spatial	Corr.	.29	.37	.11	.25	.23	.23	.06	-.04
		(p-value)	(.16)	(.10)	(.35)	(.19)	(.22)	(.21)	(.42)	(.44)
	Ling	Corr.	.29	.10	-.04	.15	.26	.09	.06	-.16
		(p-value)	(.16)	(.36)	(.45)	(.31)	(.19)	(.38)	(.42)	(.30)
	Interp	Corr.	-.14	-.04	.21	.20	.23	.17	.13	.22
		(p-value)	(.32)	(.45)	(.24)	(.25)	(.21)	(.29)	(.33)	(.23)
	Intrap	Corr.	.29	.42	.20	.12	-.05	.01	.01	.058
		(p-value)	(.16)	(.07)	(.25)	(.34)	(.43)	(.50)	(.49)	(.42)
	Nature	Corr.	.04	-.01	.06	.01	.19	.08	.11	.27
		(p-value)	(.45)	(.49)	(.42)	(.49)	(.26)	(.40)	(.36)	(.18)

Note. n=14 ** p< 0.05 level, * p< 0.10 level

Correlation Analysis of MIDAS Profiles and CBT Features

Table 4 shows all pair-wise correlations between MIDAS profiles and the CBT features. Correlations ranged from -0.52 to +0.79, thus reflecting a wide range of associations that varied from moderately/high negative to moderately/high positive correlations. Many of the correlations, however, were still near zero, thus reflecting unrelated scores. There were six significant positive correlations ($p < 0.05$ with 1-tailed tests) between the following comparisons: linguistic MIDAS and nodes total ($r = .52$, $p = .03$), interpersonal MIDAS and nodes total ($r = .58$, $p = .01$), kinesthetic MIDAS and instances total ($r = .69$, $p = .04$), spatial MIDAS and instances total ($r = .69$, $p = .04$), linguistic MIDAS and instances total ($r = .79$, $p = .02$), and intrapersonal MIDAS and instances total ($r = .72$, $p = .04$). The significant negative correlation was between linguistic MIDAS and graphics ($r = - 0.52$, $p = .03$) at the .05 cut off level (see Appendix A).

Table 4 *Matrix of Correlation Coefficients with MIDAS Profiles and CBT Features*

			MIDAS profiles							
			Music	Kinest	Math	Spatial	Ling.	Interp.	Intrap.	Nature
CBT features	Text Density	Corr.	.44	.19	.1	.43	.26	.22	.25	-.03
		(p-value)	(.06)	(.26)	(.37)	(.06)	(.19)	(.22)	(.19)	(.46)
	Screens	Corr.	.2	.05	.2	.39	.17	.11	.25	.22
		(p-value)	(.25)	(.45)	(.25)	(.09)	(.28)	(.36)	(.21)	(.23)
	Graphic Total	Corr.	-.36	-.26	.15	-.17	-.52	-.3	.05	-.15
		(p-value)	(.1)	(.19)	(.3)	(.29)	(.03)	(.15)	(.43)	(.3)
	Interactions Total	Corr.	.24	-.14	-.32	.18	.22	-.02	-.15	-.12
		(p-value)	(.2)	(.32)	(.14)	(.27)	(.22)	(.48)	(.31)	(.35)
	Nav. Total	Corr.	.01	.07	.03	.14	-.03	.28	.18	.05
		(p-value)	(.49)	(.41)	(.46)	(.32)	(.46)	(.17)	(.27)	(.43)
	Node Total	Corr.	.37	.39	.20	.47	.52	.58	.47	.23
		(p-value)	(.10)	(.08)	(.24)	(.05)	(.03)	(.01)	(.05)	(.22)
	Levels Total	Corr.	.39	.09	-.04	.41	.44	.40	.25	.08
		(p-value)	(.08)	(.39)	(.45)	(.08)	(.06)	(.08)	(.20)	(.39)
	Vocab. Total	Corr.	.66	.65	.32	.49	.65	.62	.62	.45
		(p-value)	(.06)	(.06)	(.24)	(.13)	(.06)	(.07)	(.06)	(.15)
	Inst. Total	Corr.	.64	.69	.54	.69	.79	.54	.72	.44
		(p-value)	(.06)	(.04)	(.11)	(.04)	(.02)	(.10)	(.04)	(.16)
	Activ. Total	Corr.	.50	.58	.21	.32	.48	.54	.53	.22
		(p-value)	(.13)	(.09)	(.33)	(.24)	(.14)	(.11)	(.11)	(.32)

Note. n=14. ** p< 0.05 level, * p< 0.10 level

Regression Analysis of MIDAS Profiles and CBT Reviewer Ratings

A regression analysis was also performed between this set of variables, MIDAS profiles (x) and the CBT reviewer ratings (y). To address the research question of assessing the relationship between the MIDAS profiles and CBT reviewer ratings, there was a separate regression model for each CBT reviewer ratings for all MIDAS profiles listed in the model because each variable was regressed against each of the eight MIDAS profiles; none of these results of 64 regressions, however, were significant at $p < 0.05$. Also, MIDAS profiles with a $p > .20$ were dropped, and the model was refitted to show only those MIDAS profiles with $p < .20$; so only the variables with a significant P-value of $< .20$ were used in this analysis.

Kinesthetic CBT reviewer ratings and the eight MIDAS profiles for linguistic was significant at the .20 cut off level. Math CBT reviewer ratings showed a significant relationship at the .15 cut off level when regressed against three MIDAS profiles—linguistic, math, and intrapersonal—and the eight MIDAS profiles. When the spatial CBT reviewer ratings were regressed against the kinesthetic MIDAS profiles, the results from the significance of the F-Test showed a p-value of .190. When the intrapersonal CBT reviewer ratings were regressed against the kinesthetic MIDAS profiles, the results from the significance of the F-Test showed a p-value of .138.

Regression Analysis of Math CBT Reviewer Ratings

Table 5 indicates that the math CBT reviewer ratings show a significant relationship at the .20 cut off level for four of the MIDAS profiles —linguistic, math, intrapersonal, and naturalistic. The results showed no significant relationships for the remaining four MIDAS profiles.

Table 5 *Simple Regression Analysis for Math CBT Reviewer Ratings*

MIDAS profile	Coefficient	Std. Error	P-value	R^2-value (%)
Linguistic	-.28	.167	*.126	18.4
Mathematical	-.30	.190	*.144	16.9
Spatial	-.21	.195	.302	8.8
Musical	.14	.172	.431	5.2
Kinesthetic	.01	.198	.942	0
Interpersonal	-.15	.204	.473	4.4
Intrapersonal	-.37	.223	*.120	18.9
Naturalistic	-.27	.176	*.157	16

Note: *p< .20

The results of the multiple regression, as shown in Table 6, indicated there was no significant relationship when the math CBT score was regressed simultaneously against four MIDAS: linguistic MI, math MI, intrapersonal MI, and naturalistic MI.

Table 6 *Multiple Regression Analysis for Math CBT Reviewer Ratings*

MIDAS profile	Coefficient	Std. Error	P-value
Linguistic	-.18	.209	.423
Mathematical	-.08	.372	.833
Intrapersonal	-.10	.483	.834
Naturalistic	-.08	.279	.769

Overall F-test: p = .544. R^2-value = .267 = 26.7

Regression Analysis of MIDAS Profiles and CBT Features

A separate regression model was fit for each CBT feature, with all MIDAS profiles used as predictors. Then, MIDAS profiles with a $p > 0.05$ were dropped, and the model was refitted to show only those MIDAS profiles with $p < 0.05$. Three significant regressions (at $p < 0.05$ with 1-tailed tests) were 1) graphics total and the linguistic MIDAS profiles (p-value = .054); 2) nodes total and interpersonal MIDAS profiles (p-value = .029); and 3) instances total and linguistic MIDAS profiles (p-value = .035).

Regression Results of 10 CBT features

Regression Models

There is a separate regression model for each of the 10 CBT features for all MI components listed in the model as each variable was regressed against each of the eight MI. There are two marginally significant relationships (at $p<0.20$), between the text density in the CBT and the musical MI. Similar results were found with the spatial MI. There is a significant relationship between the total number of screens in the CBT and the spatial MI. When the number of screens in the CBT was regressed against the spatial MI, the results showed a p-value of .174. No other relationships were significant at the .20 cut-off level. There is a significant relationship, at the .05 level, between the total number of graphics in the CBT and the linguistic MI. When the graphics total in the CBT design was regressed against the linguistic MI, the p-value = .054. At the .05 cut off level, there was a significant difference in the intrapersonal MI and the total number of nodes in the CBT. Similar results indicated there was a significant difference at the .10 level of significance in the spatial MI, linguistic MI, and intrapersonal MI with respect to the total number of nodes in the CBT. Music MI and kinesthetic MI were also significant with respect to the total number of nodes in the CBT at the .20 level of significance. Similar results at the .15 cut off level in linguistic MI and the total number of levels in a CBT. Also, similar results at the .20 cut off level indicated a marginally significant relationship with spatial MI, musical MI, and interpersonal MI with respect to the total number of levels in a CBT. There is a marginally significant relationship between the total vocabulary in the CBT and five MI: linguistic, music, kinesthetic, interpersonal, and intrapersonal. No other results were significant. Linguistic MI was significant at the .05

cut off level with respect to the total instances in the CBT. In a similar result, when the total instances in the CBT were regressed against three MI—spatial, kinesthetic, and intrapersonal—the results were significant with respect to the CBT total instances at the .10 cut off level.

Regression Analysis of CBT Features-Graphics

Table 7 indicates a significant inverse relationship at the .05 cut off level between CBT feature—graphics and the MIDAS profiles—linguistic. A high linguistic MIDAS profiles may decrease the CBT features-graphics and vice versa. No other results, including the multiple regression, were statistically significant at the .05 cut off level.

Table 7 *Simple Regression Analysis for CBT Features-Graphics*

MIDAS profile	Coefficient	Std. Error	P-value	R^2-value (%)
Linguistic	- 3.71	1.739	*.054	27.5
Mathematical	1.19	2.272	.610	2.2
Spatial	-1.30	2.225	.570	2.8
Musical	-2.45	1.820	.202	13.2
Kinesthetic	-1.94	2.116	.377	6.5
Interpersonal	-2.38	2.201	.302	8.8
Intrapersonal	.51	2.726	.854	.3
Naturalistic	-1.12	2.091	.602	2.3

Note. n=14. * $p< 0.05$ level

Regression Analysis of CBT Features-Nodes

As seen in Table 8, at the .05 cut off level, there was a significant association between interpersonal MIDAS profiles and the nodes total (p=0.029). The coefficient associated with the interpersonal MIDAS profiles indicates that for every percentage point increase in interpersonal MIDAS, CBT features-nodes should increase by 2.16 percentage points. The coefficient of determination (R^2) is 0.34, meaning that 34% of the total variability can be explained by the variation of the interpersonal MIDAS profiles. No other results were significant (at $p < 0.05$).

Table 8 *Simple Regression Analysis for CBT Features-Nodes*

MIDAS profile	Coefficient	Std. Error	P-value	R^2-value (%)
Linguistic	1.72	.807	.055	27.4
Mathematical	.75	1.044	.485	4.1
Spatial	1.70	.926	.092	21.8
Musical	1.17	.842	.192	13.7
Kinesthetic	1.38	.934	.164	15.5
Interpersonal	2.16	.869	*.029	34
Intrapersonal	2.06	1.120	.091	21.9
Naturalistic	.77	.957	.439	5.1

Note. n=14. * $p< 0.05$ level

Regression Analysis of CBT Features-Instances

Table 9 shows that linguistic MIDAS profiles were significant at the .05 cut off level with respect to the instances total (p-value = 0.035). The coefficient associated with the linguistic MIDAS profiles indicates that for every percentage point increase in linguistic MIDAS profiles, CBT features-instances should increase by 1 percentage point. The coefficient of determination shows that 62.1% of the total variability can be explained by the linguistic MIDAS profiles. No other results were statistically significant (at $p < 0.05$).

Table 9 *Simple Regression Analysis for CBT Features-Instances*

MIDAS profile	Coefficient	Std. Error	P-value	R^2-value (%)
Linguistic	1	.349	*.035	62.1
Mathematical	.85	.594	.212	29
Spatial	1.03	.483	.087	47.4
Musical	.92	.490	.118	41.5
Kinesthetic	.99	.469	.088	47.1
Interpersonal	.86	.596	.208	29.4
Intrapersonal	1.47	.637	.070	51.4
Naturalistic	.71	.656	.327	19.1

Note. n=14. * p< 0.05 level

CHAPTER 5

Discussion

This chapter discusses the results from chapter 4 in terms of the research question, along with a discussion of the supporting literature. The following six sections of this chapter will be discussed in this sequence. First, will be a discussion of the correlations of both the quantitative and qualitative data analyses, with an interpretation of the results of the MIDAS profiles and the CBT reviewer ratings. Second, a discussion of the regressions of both the quantitative and qualitative data analyses will follow, with an interpretation of the results of the MIDAS profiles and the CBT features. Third, the implications for instructional designers are examined with conclusions of the eight MI converged with the supporting literature. The limitations, the recommendations for further research, and some final comments are then presented.

Correlation Analysis of MIDAS Profiles and CBT Reviewer Ratings

Out of 64 correlations between the MIDAS profiles and CBT reviewer ratings performed, most of the relationships indicated a low to moderately/low non-significant correlation between MI profiles and reviewer ratings for how designers developed the CBTs. These non-significant results may seem to contradict the research, but may be due to the fact that this was a small sample size and that these students were new programming `designers. Another contributing factor may have been the inclusion of MI instruction that may have been influential whereby the students designed not just with their own preferences but with different intelligences in the CBTs.

Correlation Analysis of MIDAS Profiles and CBT Features

Out of 80 correlations between the MIDAS profiles and CBT features performed, the relationships showed a moderately/high negative to moderately/high significant positive correlation ($p < 0.05$) between the seven following correlations (Appendix A): 1) nodes and the linguistic MIDAS profiles, 2) nodes and the interpersonal MIDAS profiles, 3) instances and the kinesthetic MIDAS profiles, 4) instances and the spatial MIDAS profiles, 5) instances and the linguistic MIDAS profiles, 6) instances and the intrapersonal MIDAS profiles, and 7) graphics and the linguistic MIDAS profiles.

The results from the correlation analysis of qualitative data support the premise that one's MIDAS profiles, with regard to linguistic or interpersonal intelligences, were related to how a designer would develop a CBT program structure with CBT features such as nodes. In other words, one's own proclivities in linguistic were a highly significant association with how the student designers designed the CBTs with nodes, after having received MI instruction that indicated the MI were integrated. This conclusion may suggest that those with linguistic or interpersonal intelligences designed CBTs using more nodes. These results were based on the observations of the qualitative data that were less aggregated. Such a conclusion was beyond the scope of this study, but all the CBTs were learner-centered programs since they were focused on the needs of a learner; one such specific indication was the non-linear design. This non-linear fashion allows users to search or navigate in any direction (forward, backwards, and so on), instead of in a linear, continuous fashion.

Also, the correlation results from the qualitative data support the evidence that the MIDAS profiles, with regard to the spatial, linguistic, kinesthetic, and intrapersonal intelligences, were significantly correlated with how designers developed the CBT features with instances. Their own proclivities had a highly significant association with how the student designers developed the CBTs with instances that indicated the MI were integrated after students had received MI instruction. This conclusion may suggest that those with spatial, linguistic, kinesthetic, or intrapersonal intelligences designed CBTs using more instances that indicated the MI were integrated. These results were based on the observations of the qualitative data.

Last, the results of the correlation analysis from the qualitative data support the implication that a person's linguistic MIDAS profiles were an inverse relationship to how a designer would develop a CBT with graphics. One's own proclivities with linguistic intelligence had a moderately negative significant association with how the student designers developed the CBTs with graphics. This conclusion may suggest that student designers with high linguistic intelligences designed CBTs with fewer graphics and vice versa.

Regression Analysis of MIDAS Profiles and CBT Reviewer Ratings

None of the regressions were significant for each CBT reviewer rating for all MIDAS profiles except for the regression analysis of the qualitative data discussed next.

Regression Analysis of MIDAS Profiles and CBT Features

The research question was addressed after conducting a further regression analysis of the qualitative data of the MIDAS profiles and the CBT features, comprising a total of 80 simple regressions. This section of the study examined regressions to assess the magnitude of how two different variables, the MIDAS profiles and the CBT features, relate to the research question.

The following are the final conclusions, in light of the research question. First, the results from the regression analysis of the qualitative data support the implication that the interpersonal MIDAS profiles were significant predictors for the outcome how student developers designed CBT features such as nodes. This implies that the student developers own proclivities with interpersonal intelligence had a highly significant association with how the CBTs were designed with nodes.

Second, the results from the regression analysis of the qualitative data support the implication that MIDAS profiles with linguistic intelligence were a significant predictor for the outcome of how student developers designed the CBT features such as instances. This implies the student developers own proclivities with linguistic intelligence had a highly significant association with how the CBTs were designed with instances.

Third, the results from the regression analysis of the qualitative data support the implication that the MIDAS profiles with linguistic were a significant predictor for the outcome of how a developer designs his or her CBT features such as graphics. This implies that the student developers own proclivities with linguistic had a significant association with how the CBTs were designed with graphics.

Summarizing this analysis of the qualitative observational review of the data between MIDAS profiles and the CBT features showed three significant regressions (at $p < 0.05$ with 1-tailed tests) between the following comparisons: graphics and the linguistic MIDAS profiles; nodes with interpersonal MIDAS profiles; and instances with linguistic MIDAS profiles.

Therefore, this research question was assessed with these significant regressions of the qualitative findings that showed the MIDAS profiles, which indicated designers' own proclivities, automated preferences or natural MI predispositions, had a significant association with student CBT developers when they designed CBTs regarding these nodes, instances, and graphics.

Furthermore, the association between the MIDAS profiles and the two CBT features showed that the group of 14 student CBT developers created CBTs in which two of the CBT features, both nodes and instances, exhibited their highest MIDAS profiles. Therefore, this is a reasonable conclusion because some of the relationships between the two variables, MIDAS profiles and the CBT features, designed by the students, indicated significant findings (at $p < 0.05$). The importance of these specific findings and their meaning for instructional designers will be further interpreted in the following sections.

The regression and correlation did not show the same thing. The correlations revealed the strength of the relationship between the two variables, but the regressions assessed the magnitude to predict the outcome of the two different variables' relationship. One might also wonder why a relationship shows up through the regression analysis of qualitative data but not the quantitative data. This may appear to contradict the research hypothesis, but it can potentially be explained by noting that the qualitative data were less aggregated in terms of the specific focus on indicators of the features captured.

Implications for Instructional Designers and Practitioners: Interpretations, Conclusions, and Insights

Next, results are discussed in light of past research and interpreted in view of the research question and supporting literature. This section is organized by discussing the interpretation and the implications of the results for instructional designers and for practitioners with each of the eight MI in this order: musical, kinesthetic, logical-mathematical, spatial, linguistic, interpersonal, intrapersonal, and naturalistic.

Significance of Eight MI Forged with Past Research

Musical

Data gathered from this study showed no relationship between the musical MIDAS profiles and the musical CBT reviewer rating either in terms of correlations or regression models. The musical MIDAS profiles were one of the lowest values, as were the eight CBT reviewer ratings. A likely conclusion could be that designing CBTs with music entails more time and in-depth lessons surpassing the CBT course objectives. In addition, musical MI are simply non-traditional intelligences as compared to the traditional methods of instruction with linguistic and math.

It is beyond the scope of this study, but an implication drawn from this result means that in order to integrate the musical intelligences, professors teaching classes in CBT could encourage students to design CBTs enhanced with musical activities. Furthermore, multimedia professors could demonstrate, via a CBT, how the use of different music formats, can be used by the students to design a CBT program. The MIDI system, short for Musical Instrument Digital Interface, is one format that could be demonstrated. The MIDI, a digital format for music, allows for digital electronic musical instruments to communicate with one another and with a computer in order to compose and edit electronic music.

Several studies support these implications for integrating the musical intelligence. Music is the strongest intelligence for high school students (Ashmore, 2003), especially for females (Snyder, 2000), and the primary intelligence for preschool-age children (Acuff, as cited in Ashmore, 2003). It is crucial that a multimedia lecture include musical elements for those with high musical intelligences, or they will not benefit from the lecture (Sanders, 2002). This implication is consistent with Ashmore's (2003) finding that Web sites with music engage learners with high musical MI.

Kinesthetic

The kinesthetic MI indicated a low or nonexistent relationship between the kinesthetic MIDAS profile and the kinesthetic CBT reviewer rating; however, the correlation results of the qualitative data between kinesthetic MIDAS profiles and CBT features with instances showed a significant moderate to high positive correlation total ($p < .05$).

Kinesthetic, or Body Smart, is the use of the body in activities (Armstrong, 1994). Based on the results of the significant number of instances using the kinesthetic intelligences, a likely conclusion is that the CBTs, overall, showed use of the body in an activity such as demonstrating physical sports or activities in the CBT that involved fine motor skills. A possible conclusion could be that kinesthetic intelligences are also simply non-traditional intelligences. This is important for CBT designers because these findings validate integrating various MI and support the idea that training in the MI can help designers incorporate non-traditional intelligences. It would be useful for CBT designers to know that the CBT designs could have the users view an activity, but also they could have the users think in movements to do a task. Another important implication, useful for a person teaching classes in CBT, is to encourage individuals to design with activities.

For example, they could simulate the planets orbiting the sun or short video clips of how to play soccer.

The correlation results are consistent with Malm's (2001) study of adult learners who completed the MIDAS survey, which showed that the comparison group had lower scores in kinesthetic. Several studies pointed out the value of incorporating the kinesthetic intelligence for children: Ashmore (2003) noted, with reference to both Teele and Shearer, that kinesthetic intelligence was one of the four most important intelligences for kindergartners. Shore's (2001) analysis revealed a strong positive correlation between kinesthetic intelligence with writing self-efficacy. Snyder's (2000) study revealed kinesthetic intelligence as important for high school students, as the majority (81%) were tactile/kinesthetic learners. It showed as males' most dominant intelligence, and for females, there was a positive correlation between GPA and kinesthetic intelligence.

Math

Math intelligence, or Number/Logic Smart (Armstrong, 1994), has an interesting result. The math CBT reviewer ratings show a significant relationship at the .20 cut off level when regressed with the math MIDAS profile. It suggested an inverse relationship, indicating that as math intelligence increases, its use will decrease in the CBT.

These results indicated that when the student designers had a high MIDAS profile in math, they did not design a CBT using their strength in math. Therefore, it implies that the students are not designing with their strengths. However, it is good to design using one strengths but, at the same time, it is also good to use additional intelligences. Absolutely, one would not sacrifice designing with one's own strength but only to a certain extent; one's strength or strongest intelligence, if used solely by itself without integrating other MI, may orchestrate designer-centered CBTs. Effective CBT instructional design is to create learner-centered CBTs using one's strengths with additional MI integrated.

This is a critical clue that is important for those in the field of instructional design to consider in their practice. Specifically, they need to consider knowing their own strengths. The intensive ID process requires the skills of many specialists (instructional designers, programmers, artists, usability engineers, etc.); however, it may not be fully implemented by a single designer. If these strengths were known, then a designer could build on his or her strengths but at the same time integrate additional intelligences for the needs of *all* because *no one way is best for all.* One's strongest intelligence would not solely dominate the CBT design.

These findings are supported with the results of Smith (2003), who claims it is important to know one's strengths so that a variety of instructional strategies can be integrated to support them. Furthermore, if one's learning preferences are strengthened, achievement is increased, and student satisfaction rises when instructional strategies support one's dominant intelligence (Smith). Therefore, a conclusion from the results and literature show how imperative it is to involve the MI—a vital concept for any team that develops CBTs.

Spatial

There was not a strong positive relationship between the spatial MIDAS profiles and the CBT reviewer ratings except in the further analysis of the CBT features. There were significant findings of using spatial MIDAS profiles and the number of instances in the CBT features. Specifically, spatial MIDAS profiles correlated significantly with instances ($p < .05$).

Spatial, or Picture Smart (Armstrong, 1994), implies that these results could be useful for practitioners in the field of instructional design. If CBT developers have an awareness of their MI and learners' needs, they could design with their highest spatial intelligence. Furthermore, they could combine their strengths in this intelligence with another intelligence such as linguistic intelligence. The use of pictures or visuals is an example of spatial intelligence that could be combined with the use of verbal cues, an example of linguistic intelligence. Supporting evidence by Moreno and Valdez (2005) pointed out that learning with visuals or pictures with verbal materials or text is significantly more efficient than learning with pictures alone or text alone.

This represents useful clues for instructional designers about how to design CBTs to appeal to more individuals. Another important implication, useful for a person teaching classes in CBT, is to have their student CBT developers who have a high spatial intelligence to create a visual experience with imagination in the CBT program.

These findings are consistent with the results of Snyder’s (2000) study that male high school students were strong in the spatial intelligence as it was one of the four most dominant for high school students noted by Shearer’s 2002 MIDAS and Teele's 1994 TIMI (as cited in Ashmore, 2003). Furthermore, findings from Shearer, Teele, and Acuff (as cited in Ashmore, 2003) show kindergartners to be strong in spatial intelligence.

Linguistic

Linguistic or Word Smart (Armstrong, 1994), showed the linguistic MIDAS profiles were in the top three of the eight means of the MIDAS profiles. There was no significance in the correlations in the CBT design with linguistic MIDAS due to the moderate/low correlation. A possible conclusion is the small sample size. Further analysis of the qualitative data showed the linguistic intelligence in the CBT features had an association with regard to instances, nodes, and graphics.

There was a positive, significant relationship between linguistic MIDAS and the instances, both in terms of the correlations and regression models. This suggests that those with linguistic intelligence designed CBTs using more instances or indicators of MI overall.

Second, there was a positive, significant relationship between linguistic MIDAS and the nodes in the correlations. It suggests that the 14 CBT developers, overall as a group, were strong in linguistic intelligence and designed CBTs utilizing nodes. These results are useful for instructional design practitioners because it gives insight to those with linguistic intelligence who may be able to design and control extremely complex CBT lessons such as nodes. Nodes can allow a user different paths of navigation that are needed to branch off to present supplementary material. Nodes in the levels allow users increased control over a lesson to select the appropriate links for a given task, similar to aircraft simulator technology. The overall ratio of navigation links to the nodes is about 1.9 : 1, which means that, overall, there were 1.9 navigation links for every 1 node. For one example, student #1 shows a ratio of 4 navigation links : 1 node. (see Appendix L).

Third, there was an inverse (and significant) relationship between the linguistic MIDAS profile and the number of graphics, both in terms of the correlations and regression models. Overall, a student with a predisposition or natural propensity for linguistic intelligence had a tendency to use considerable instances and nodes and fewer graphics in the CBT. To address what it means about a student high in linguistic to those teaching CBT is that they could encourage the student to use this strength with linguistic intelligence, but to use images through the use of colorful words and also to help the student to develop intelligences besides his or her strong intelligence. Specifically, the student could be encouraged to add music to a poem images through the use of colorful words in a CBT. In terms of what it means to a designer high in linguistic, is to capitalize on this strength but may draw on other strengths in order to design a learner-centered CBT focused on all of the learners' needs.

Findings are supported with Snyder's (2000) study from the literature review that showed a positive correlation between preferring to work alone and linguistic intelligences. The student CBT designers had a high linguistic MIDAS, designed a CBT high in linguistic intelligence, and worked alone on designing a CBT. The findings are also supported with Shore's (2001) findings of a strong positive correlation between linguistic and writing self-efficacy as individuals have higher levels in self-efficacy when their own learning styles, cultural backgrounds, and MI-based lessons are used. This lends more support for the use of MI Theory-based lessons.

Interpersonal

Interpersonal or People Smart (Armstrong, 1994), showed no relationship existed between interpersonal MIDAS profiles and the interpersonal CBT reviewer ratings except in the qualitative review with respect to the nodes. In other words, even though the interpersonal MIDAS profiles were the second highest of all of the MIDAS profiles, the results showed a non-significant low positive correlation, showing no relationship because the interpersonal intelligence was not used frequently in the CBT design except for the nodes. Interpersonal MIDAS profiles and nodes were one of the highest significant correlations ($p < .05$) suggesting that those with strong interpersonal intelligence used more nodes in the CBT design, implying that student developers were sensitive, aware, and concerned about others' needs, which is how the interpersonal MIDAS profiles are defined.

Therefore, it was the further analysis of the qualitative data that showed the interpersonal intelligence in the CBT features had an association with regard to nodes both in terms of the correlations and regression models. A possible conclusion could be that the students, after instruction on using the MI to design CBTs, improved by integrating other types of intelligence into the CBT design.

Nodes were the building blocks from which the individuals fabricated a program structure with a user-friendly interface and learner-centered CBT design to meet the needs of *all* learners. Symbolically, these nodes, a window or a computer screen that holds links to information were a *window of opportunity* that displayed more information on a screen and thus, that enabled the learner or user to make choices and take charge of his or her own learning. These nodes enabled the learners or users to navigate from screens, using links such as buttons, menus, etc., to show a new node. Therefore, the nodes actually showed the depth of the navigation of a CBT.

The data showed a high interpersonal intelligence and a low naturalistic, which is consistent with the results of Malm's (2001) study, in which adult learners in a community college who completed the MIDAS survey showed interpersonal intelligence as one of the highest MI and naturalistic as the lowest. This finding supports the idea that MI strategies need to be developed. Furthermore, this suggests that a high interpersonal intelligence is not limited just to children because the self-reported high scores in interpersonal serve as a critical educational clue for college professors of the adult population and show that additional research needs to be done for this population.

Intrapersonal

Intrapersonal or Self Smart (Armstrong, 1994), showed there was no significant relationship between the MIDAS profiles and the CBT reviewer ratings due to the weak correlation. In spite of those findings, further analysis of the qualitative data showed the intrapersonal MIDAS profiles had a relationship with instances with one of the highest significant correlations ($p < .05$) suggesting those with strong intrapersonal intelligence used a moderately/high significant number of instances of integrating MI into the CBTs.

A possible conclusion was that the adult students displayed traits of the intrapersonal intelligence: they learned through observing, listening, and then pursued personal interests in the CBT design. This implies that an instructor can allow adult individuals to work alone at their own pace and provide feedback as needed. The results in view of the literature give some useful insight for an instructor teaching classes in CBT. We can hypothesize that the significant number of instances may be due to the intrapersonal intelligences that are high in adult individuals (as noted by Malm, 2001). Intrapersonal is also the dominant intelligence for female high school students (Snyder, 2000) and one of the four strongest intelligences for kindergartners, ages 5-7 (Ashmore, 2003). A strong positive correlation was found between intrapersonal intelligence and writing self-efficacy (Shore, 2001).

Naturalistic

There was no significant relationship between the MIDAS profiles and the CBT reviewer ratings. It was used the least in the CBT design and it was the lowest intelligence on the MIDAS profiles, showing that the students possessed little predisposition for naturalistic intelligence and did not design CBTs with this intelligence. (see Appendix C).

Naturalistic intelligence, the lowest intelligence for the student CBT developers, was expected because it is typical for adults to have the lowest intelligence in naturalistic. This conclusion is supported with findings consistent with research that adult learners in a community college had naturalistic intelligence as the lowest intelligence on the MIDAS survey (Malm, 2001).

Furthermore, we can speculate that it is useful for professors to give MI instruction because when students are given instruction using the MI, they will start to use naturalistic intelligences and other types of intelligences. This conclusion is supported with findings consistent with research by Ozdemir, Guneysu, & Tekkaya, 2006). There is relevance to all practitioners in the CBT field who would benefit from learning about MI and how they apply to the adult. This means that in order to integrate the naturalistic intelligences, professors teaching classes in CBT would encourage students to design CBTs enhanced with naturalistic activities.

The walls of multimedia classrooms will naturally come down if multimedia individuals and the CBT field collaborate and become partners with business and industry such as The National Aeronautics and Space Administration (NASA), Department of Environmental Resources (DEP), scientists, and many other professions in order to integrate the naturalistic intelligences. Specifically, the multimedia students could monitor the wetlands with the DEP and build educational CBTs around this naturalistic activity. Secondly, the multimedia students, in partnership with The National Aeronautics and Space Administration (NASA), could create CBTs with scientific equipment.

Limitations

Sample

This study was limited to one university in western Pennsylvania and to a small sample size. The subjects were limited to 14 students in a multimedia graduate program for this study. Student designers developed CBT software in an educational course from start to finish with limited design iterations (formative evaluations) or external review. The development of the CBT was limited to the students so the findings were also limited to the students learning how to design CBT programs. The results could have been different if the participants had possessed 20 years of design experience. Therefore, these findings are limited to small groups of instructional designers, such as students or small teams of developers, and not able to be generalized for all instructional designers.

MI Lesson

A further limitation was the classroom training the students received. The instructor gave the students one lesson on MI, and the researcher provided information about MI on a CD. This may have been inadequate, not only because students were new to ideas about MI and how to integrate them into the CBT design, but also because the student designers were just learning how to develop a CBT and were new to the design development process. Therefore, a new student may have had difficulty with the concept of MI and with trying to use this theory to design a CBT. In some cases, the nature of the

MI and how the ideas are integrated into a CBT may require a degree of complexity beyond the capabilities of a student designer who is new to the design development process. An experienced team of developers, who have individual predispositions and not a team predisposition, could follow an iterative review process.

Recommendations

MI Strategies

One recommendation is to use instructional strategies to bridge together MI with the ID process used to create CBTs. Future research should focus on strategies to integrate a more varied range of MI because these findings have indicated the relevance of integrating MI in a CBT. More research is needed to help design CBTs with MI. The importance of MI is supported in the research.

Rubric

One recommendation for instructional designers is to use the MI rubric as a guideline to help them create CBTs using effective MI strategies. (see Appendix O).

MI Design Model

Another recommendation would be to use the MI design model by Tracey (2001) with the instructional design model that one uses (see Appendix M).

Subjects

This study should be replicated with an increased number of subjects in order to increase our power to detect associations. Another recommendation would be to do a comparison study using the same variables.

Final Comments

This study was a synthesis of empirically-based literature with evidence of the relationship between MI and CBT design. This study points in a new direction by establishing an explicit link between CBT design and the MI. Integrating MI strategies into CBT design requires educating multimedia instructional designers in sound instructional design conceptions, using multimedia CBT authoring applications, in order to transform the design and development of CBTs. Equally important, software programs for CBT purposes can be designed to interface with any or all of the intelligences (Armstrong, 1994). In order for MI to be integrated into CBT design, developers need instruction on the interconnectedness of MI and CBTs. This instruction needs to include strategies for developers' to integrate MI into CBTs. The literature for CBT developers on integrating MI Theory into their designs is scarce, so this study attempted to fill a gap in the existing literature. However, the MI model can be used as a process to help CBT designers. Also, the MI rubric can to be used as a tool to evaluate CBTs. In designing CBTs, the focus should be on the learners' needs because of the unique learning preferences of students and because achievement increases when instruction matches one's preference, one's preferred modality (Dunn et al., 1989).

Overall, this researcher advocates the benefits of linking MI to CBT design for learners' needs. If we can educate CBT developers who cannot fully implement ISD processes, they would benefit from understanding the association between MI and CBT design. The greatest impact of this study is showing the beneficial evidence of integrating MI Theory into the CBTs design. The inclusion of MI instruction enhances CBTs because they will be designed not just with one's own preferences, but with different intelligences or combinations of intelligences embedded within the instructional materials of the CBTs (Andrade & Boulay, 2003).

In conclusion, it is hoped that design and theory components will be bridged together to enhance learning with learner-centered CBTs. Last, it must be noted that this research was significant because it explained how to improve methods to enhance CBTs for *all* learners.

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Appendix A

Significant Results

QUALITATIVE	MIDAS	FEATURES	TYPE	r and p-values
Correlation*	Spatial	Instances	Mod./high	r = .69, p = .04
Correlation*	Linguistic	Instances	Mod./high	r = .79, p = .02
Correlation*	Kinesthetic	Instances	Mod./high	r = .69, p = .04
Correlation*	Intrapersonal	Instances	Mod./high	r = .72, p= .04
Correlation	Linguistic	Nodes	Moderate	r = .52, p = .03
Correlation	Interpersonal	Nodes	Moderate	r = .58, p = .01
Correlation	Linguistic	Graphics	Mod. Neg	R = -.52, p = .03
Regression	Linguistic	Graphics		p-value=.054
Regression	Interpersonal	Nodes		p-value=.029
Regression*	Linguistic	Instances		p-value=.035

Note. n=14, n= 7*, p< 0.05 level

Appendix B

MIDAS Profiles (individual scores)

Student	Musical	Kinesthetic	Math	Spatial	Linguistic	Interp	Intrap	Naturalistic
1	14	30	42	39	39	52	42	50
2	31	32	44	36	25	42	43	25
3	59	55	40	55	45	38	46	34
4	66	86	75	77	84	93	79	64
5	57	71	93	91	83	70	74	63
6	75	44	41	78	87	71	49	39
7	46	40	67	59	52	28	45	52
8	75	65	69	83	68	70	68	45
9	77	71	62	77	76	74	63	81
10	57	50	75	72	45	49	61	47
11	44	69	68	58	66	72	56	47
12	83	55	33	43	65	59	23	7
13	29	27	44	45	49	58	54	22
14	50	69	53	55	40	68	55	50

Appendix C

CBT (Reviewer Ratings) Scores of Individual Students (N=14)

Student	Musical	Kinesthetic	Math	Spatial	Linguistic	Interp	Intrap	Naturalistic
1	1.6	22	10	41.6	33	50	20	0
2	0	13.8	30	27.7	21.6	0	20	0
3	38.3	55.5	31.6	55.5	48.3	2.1	28.3	0
4	8.3	2.7	1.5	38.8	53.3	25	23.3	16.6
5	31.6	27.7	6.6	52.7	33.3	39.6	26.7	0
6	11.6	13.8	18.3	47.2	45	25	13.3	0
7	0	8.3	8.3	19.4	41.6	2	13.3	27.7
8	10	8.3	23.3	38.8	33.3	0	16.6	0
9	0	16.6	21.6	33.3	31.6	2	20	47.2
10	1.6	77.7	33.3	58.3	48.3	29	36.6	0
11	0	22.2	25	58.3	33.3	2.1	23.3	8.3
12	0	36.1	36.6	50	45	14.5	30	8.3
13	13.3	19.4	10	27	48.3	0	5	38.8
14	0	55.5	41.6	41.6	36.6	0	23.3	0

Appendix D

Average of Four Reviewer Ratings of Rubrics for Students CBTs

Multiple Intelligence	CBT Reviewer #1	CBT Reviewer #2	CBT Reviewer #3	CBT Reviewer #4	Avg.
1. Musical					
2. Kinesthetic					
3. Mathematical					
4. Spatial					
5. Linguistic					
6. Interpersonal					
7. Intrapersonal					
8. Naturalistic					

Sample:

Reviewer #1 Student #1

MI-musical

1. This student's CBT exhibited strong musical tendencies.

Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
(No evidence)	***(Some evidence)***		***(Good evidence)***	***(Significant evidence)***
__________	__________	__________	__________	__________

Appendix E

Descriptives: Qualitative CBT features

Features	Mean	Standard Deviation	Minimum	Maximum	Range	Std. Error of Mean
Text Density	5271.79	78135600	409	30855	30446	2088.26
Screens	57.07	19.53	20	90	70	5.22
Graphic Total	167.29	138	39	488	449	36.88
Interactions	21.43	11.35	11	57	46	3.03
Navigation	124.86	70.94	20	299	279	18.96
Node	65.71	64.04	12	240	228	17.12
Level	4	1.52	3	8	5	0.41
Vocabulary	183.14	184.82	26	535	509	70
Instances	45.71	30.94	11.5	96.5	85	11.7
Activities	56.14	60.45	14.5	182	167.5	22.85

Appendix F

Text Density and Length (number of screens)

CBT	Text Density - # of words	Length - # of Screens
1	735	59
2	3362	77
3	5351	46
4	4749	71
5	1650	53
6	10910	90
7	1182	50
8	30855	67
9	2068	52
10	3878	86
11	2772	52
12	3131	38
13	409	20
14	2753	38
TOTAL	73805	937
AVERAGE	5271	66.93

Appendix G

Media-Number of Media Elements

(text, images, sound, video, animations/transitions)

CBT	Graphic buttons	Graphics, images	Sound	Video	Animation/ Transitions	Total
1	55	75	5	1	19	155
2	330	114	2	1	6	453
3	0	99	8	1	43	151
4	34	49	3	2	0	88
5	104	68	3	1	23	199
6	5	69	1	1	1	77
7	0	25	1	1	12	39
8	0	100	4	0	0	104
9	21	36	2	1	6	66
10	319	150	10	9	0	488
11	130	66	1	0	5	202
12	0	47	1	1	5	54
13	66	67	2	2	2	139
14	72	44	7	1	3	127
TOTAL	**1136**	**1009**	**50**	**22**	**125**	**2342**
AVERAGE	**81.14**	**72.07**	**3.57**	**1.57**	**8.93**	**167.3**

Appendix H

Vocabulary-Instances-Activities

CBT-Avg. of 2 reviewers Vocabulary	Musical	Kinesthetic	Math	Spatial	Linguistic	Interp	Intrap	Naturalistic
1	0	0.5	7	4	15		2	1
2	0	1.5	41	3.5	22	3.5	0.5	0
3	172.5	1	30	4.5	6.5	6	0	2
4	2	6	115	222.5	60	50	22.5	57
5	47	3	20	1	9	6	2	0
9	0	2	38	15	24	5.5	1	212.5
14	0	4	11	3	6	0	0	2
CBT-Avg. of 2 reviewers Vocabulary	Musical	Kinesthetic	Math	Spatial	Linguistic	Interp	Intrap	Naturalistic
1	0	0	0	12.5	1	9.5	1	1
2	0	0	2	4	3	1.5	1	0
3	28	2	5	10.5	8	9.5	2	0
4	0	6	0	39.5	33	3.5	1	13.5
5	8.5	3	14	11	9.5	11	1	1
9	0	4	0	14	4.5	5	0	21.5
14	0	0	0	11	2.5	0.5	0	0
CBT-Avg. of 2 reviewers Vocabulary	Musical	Kinesthetic	Math	Spatial	Linguistic	Interp	Intrap	Naturalistic
1	0	6	4	4	2	0	0	0
2	0	5.5	6	4	7	3	0	0
3	9.5	6	14	24	20.5	7	0	0
4	1.5	6	6	19.5	39.5	52	0	57.5
5	4	1	1	5	3.5	0	0	0
9	1.5	3	24	11.5	6	5	0	1.5
14	0	12	2	6	2	0	0	0

Appendix I

Interactions

CBT	Click	Drag	Keypress	Feedback	Tries	Time	Fill in text	Total
1	3	1	2	5	0	0	5	16
2	3	1	4	10	4	0	3	25
3	4	1	3	10	6	4	3	31
4	3	0	2	6	5	1	2	19
5	2	1	2	8	3	0	2	18
6	5	1	7	22	15	2	5	57
7	1	6	2	5	5	1	1	21
8	2	1	2	7	3	0	2	17
9	2	1	2	6	2	0	1	14
10	3	1	1	7	1	2	2	17
11	1	0	3	5	3	2	4	18
12	2	1	1	5	3	2	1	15

Appendix J

Nodes and Levels

CBT	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	# Nodes	# Level
1	4	1	40	0	0	0	0	0	45	3
2	5	1	18	12	14	0	0	0	50	5
3	3	1	31	0	0	0	0	0	35	3
4	2	1	53	75	83	26	0	0	240	6
5	4	1	26	0	0	0	0	0	31	3
6	1	1	14	52	24	40	19	9	160	8
7	2	14	11	0	0	0	0	0	27	3
8	2	1	76	26	10	0	0	0	115	5
9	4	2	1	23	0	0	0	0	30	4
10	4	1	40	27	0	0	0	0	72	4
11	4	1	39	0	0	0	0	0	44	3
12	4	1	25	0	0	0	0	0	30	3
13	0	1	11	0	0	0	0	0	12	3
14	5	1	23	0	0	0	0	0	29	3
Total	44	28	408	215	131	66	19	9	920	56
Avg.	3.14	2	29.14	15.36	9.36	4.7	1.36	0.64	65.7	4

Appendix K

Navigation

CBT	Menu buttons	Pull Down Menus	Forward (Pacing) buttons	Prev. screen buttons	Go Back to Main Menu	Quit buttons	Quiz buttons	Total Nav. buttons
1	5	22	46	38	38	37	0	185
2	7	11	66	10	13	34	34	175
3	7	15	17	5	0	0	22	66
4	7	8	12	21	28	19	0	95
5	7	5	28	0	12	15	15	82
6	6	7	94	5	45	0	0	157
7	9	8	2	0	0	1	0	20
8	11	0	79	31	58	57	63	299
9	7	10	22	9	17	20	20	105
10	6	37	48	39	3	0	0	133
11	5	9	34	29	30	34	30	171
12	3	7	26	17	17	0	0	70
13	6	6	7	5	10	10	10	54
14	5	0	62	22	22	1	24	136
TOTAL	**90**	**145**	**543**	**231**	**293**	**228**	**218**	**1748**
AVERAGE	**6.43**	**10.36**	**38.79**	**16.5**	**20.93**	**16.29**	**15.6**	**124.9**

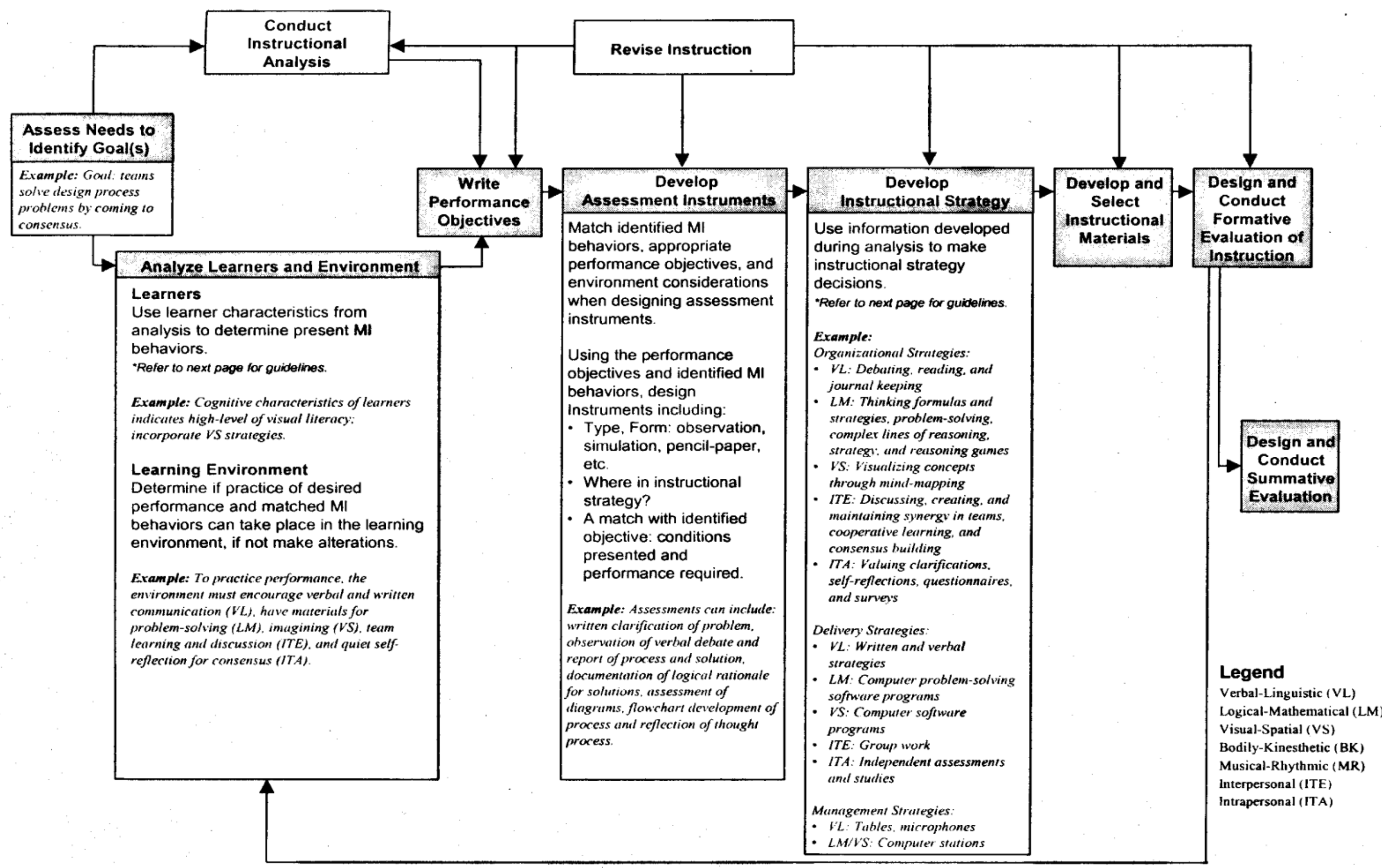
Appendix L

Ratio of Navigation Links to Nodes

Student	Navigation	: Nodes	=	Ratio	Is:
1	185	: 45		4.11:	1
2	175	: 50		3.5:	1
3	66	: 35		1.89:	1
4	95	: 24		1:00	2.52
5	82	: 31		2.65:	1
6	157	: 160		1:00	1.01
7	20	: 27		1:00	1.35
8	299	: 115		2.6:	1
9	105	: 30		3.5:	1
10	133	: 72		1.85:	1
11	171	: 44		3.89:	1
12	70	: 30		2.33:	1
13	54	: 12		4.5:	1
14	136	: 29		4.69	1

Appendix M

MI Design Models And Lesson Planning



Note. From The construction and validation of an instructional systems design model incorporating multiple intelligences, copyright 2001 by Tracey, M. W., p. 89-90.

Appendix N

Dr. Howard Gardner, MI Theorist

Howard Gardner, Ph.D. is a Professor of Education at Harvard, Hobbs Professor of Cognition and Education, Chairman of the Steering Committee of Project Zero the Harvard Graduate School of Education, Professor of Neurology at the Boston University School of Medicine. He is the author of over 18 books, including *Frames of Mind*, *The Unschooled Mind*, *Creating Minds*, *Leading Minds*, *MI*, and *Intelligence Reframed*. He has been honored with the MacArthur *Genius* award, the University of Louisville Grawemeyer Award and eighteen honorary doctorates. He lives in Cambridge, Massachusetts.

Dr. Howard Gardner believes that each person possesses all eight intelligences and that most people can develop each intelligence to an adequate level of competency. Intelligences usually work together in complex ways and there are many ways to be intelligent within each category.

.

Dr. Howard Gardner
(From http://www.ips.k12.in.us/mskey/theories/theories.html)

Appendix O

Assessment Criteria Rubric©--Integrating Multiple Intelligences

into the Design of Computer-based Training (CBTs) by Nancy Marie King

1. **MI Intelligence**	**CBT content/skills-Provides examples and shows evidence of effectively using:**	**Significant Evidence (3)**	**Good Evidence (2)**	**Some Evidence (1)**	**No Evidence (0)**
MUSICAL Sample Activities: Musical beat Sound, rhyme, rhythm, repetition and melodies Choral, instrument Song, lyric to explain Voice-to say outloud, hum Connections between music and emotions Dance, dance move Listens to music, then creates a song Make up songs, poetry		*Exceeds Providing outstanding effective examples to have the learner think in sounds, rhythms, melodies and rhymes.*	*Appropriate use of MI strategies or activities. Provides good examples* to *have the learner think in sounds, rhythms, melodies and rhymes.*	*Displays general understanding of integrating MI activities Provides some examples* to *have the learner think in sounds, rhythms, melodies and rhymes.*	*Lacks MI strategies or activities. Provides no examples to have the learner think in sounds, rhythms, melodies and rhymes*
To have the learner think in sounds, rhythms, melodies and rhymes.	Content-MI Strategies: Vocal Ability: singing in tune and harmony-good rhythm Instrumental Skill: plays an instrument Composing makes up songs or poetry Active Listener-Appreciation: active interest in music	_______ _______ _______ _______ _______	_______ _______ _______ _______ _______	_______ _______ _______ _______ _______	_______ _______ _______ _______ _______
TOTAL	(Possible 15 points)				

2. **MI Intelligence**	**CBT content/skills- Provides examples and shows evidence of effectively using:**	**Significant Evidence (3)**	**Good Evidence (2)**	**Some Evidence (1)**	**No Evidence (0)**
KINESTHETIC Sample Activities: Fine-motor movements of ones fingers and hands-working with hands to manipulate objects. Gross-motor movement-Building things, tinker, taking things apart and back together again ex. build a model, puzzle. Physical dexterity-full body movements-use of whole body movement. Physical ability-dance and sports such as run, jump, skip, hop, roll, ride, bike, ski, balance, karate		*Exceeds providing outstanding effective examples of having the learner think in movements and use the body in a skilled complicated way.*	*Appropriate use of MI strategies or activities. Provides good examples to having the learner think in movements and use the body in a skilled complicated way.*	*Displays general understanding of integrating MI activities. Provides some examples to having the learner think in movements and use the body in a skilled, complicated way.*	*Lacks MI strategies or activities. Provides no examples to having the learner think in movements and use the body in a skilled, complicated way.*
To have the learner think in move-ments and use the body in a skilled way.	Content-MI Strategies: Athletics: involves physical movement and other athletic activities Physical Dexterity: Working with hands. Expressive movement -using one's hands when working with objects -uses body for learning, dancing, acting	_______ _______ _______	_______ _______ _______	_______ _______ _______	_______ _______ _______
TOTAL	(Possible 9 points)				

3. **MI Intelligence**	**CBT content/skills-Provides examples and shows evidence of effectively using:**	**Significant Evidence (3)**	**Good Evidence (2)**	**Some Evidence (1)**	**No Evidence (0)**
MATH Sample Activities: Analytical reasoning Logical thinking, analysis and synthesis of ideas Critical,creative and complex problem-solving Explore possibilities Bargaining, making a deal with people Ask why, what and how Step by step explanation in detail Collect, compare and critique Question, count and categorize Calculate, quantify Curiosity Inductive-deductive Reasoning skills		*Exceeds providing outstanding effective examples of having the learner think in cause effect connections and understand relationship between actions, objects or ideas.*	*Appropriate use of MI strategies or activities. Provides good examples to having the learner think in cause effect connections and understand relationship between actions, objects or ideas.*	*Displays general understanding of integrating MI activities. Provides some fair examples to having the learner think in cause effect connections and understand relationship between actions, objects or ideas.*	*Lacks MI strategies or activities. Provides no examples to having the learner think in cause effect connections and understand relationship between actions, objects or ideas.*
To have the learner think in cause effect connection and under-stand relation-ship between actions, objects or ideas.	Content-MI Strategies: School Math: does well in studying math Everyday skill with math: uses math effectively in everyday life Everyday problem-solving (logical reasoning) use of logical reasoning solve everyday problem curious, investigative Strategy games: good use of games with skill and strategy	_______ _______ _______ _______ _______	_______ _______ _______ _______ _______	_______ _______ _______ _______ _______	_______ _______ _______ _______ _______
TOTAL	(Possible 15 points)				

4. **MI:** **SPATIAL**	**CBT content/skills- Provides examples and shows evidence of effectively using:**	**Significant Evidence (3)**	**Good Evidence (2)**	**Some Evidence (1)**	**No Evidence (0)**
Sample Activities: Working with objects effectively Draws learner to use imagination, watch, visualize, sketch Use of valuable visual maps to organize information Exceeds with demonstrated use of eye-hand coordination Demonstrates space awareness-moving objects thru space to solve a problem of spatial orientation ex. Driving a car Utilizes aesthetic judgement Demonstrates all at once to get big picture Solve scientific problem Make, fix, assemble things or build with boxes, blocks Reading or drawing maps, graphs Design Create cartoons, picture book Label shelves Hair styling Create artistic designs-ex. Paintings, Drawings, crafts Design things-ex. Art, landscape, arrange furniture, decorate room, craft project Make a pattern-sewing, carpentry Fix things-cars, lamps, etc. Put things together-ex. Electrical equipment, puzzles, toys, blocks Play pool, darts, bowling Parallel park a car on 1st try Collection-ex. Dinosaurs, horses, dolls Make notes with different color pens Organize info in a colorful spatial layout Show 3 times		*Exceeds providing outstanding effective examples of having the learner think in 3-Dimensions, pictures and to perceive the visual world accurately. To recreate ones visual experience with imagination*	*Appropriate use of MI strategies or activities. Provides good examples of having the learner think in 3-Dimensions, pictures and to perceive the visual world accurately. To recreate ones visual experience with imagination.*	*Displays general understanding of integrating MI activities. Provides some fair examples to have the learner think in 3-Dimensions, pictures and to perceive the visual world accurately. To recreate ones visual experience with imagination.*	*Lacks MI strategies or activities. Provides no examples to have the learner think in 3-Dimensions, pictures and to perceive the visual world accurately. To recreate ones visual experience with imagination.*
To have the learner think in 3-Dimen-sions, pictures and to perceive the visual world accurately To recreate ones visual experience with imagina-tion.	Content-MI Strategies: Spatial awareness: solve problems involving spatial orientation and moving objects through space such as finding ones way around Working with objects; building, arranging, decorating or fixing things requiring eye-hand coordination Artistic design: use of aesthetic judgment and design	_______ _______ _______	_______ _______ _______	_______ _______ _______	_______ _______ _______
TOTAL	(Possible 9 points)				

5. **MI Intelligence**	**CBT content/skills-Provides examples and shows evidence of effectively using:**	**Significant Evidence (3)**	**Good Evidence (2)**	**Some Evidence (1)**	**No Evidence (0)**
LINGUISTIC Sample Activities: Telling stories Making up rhymes, jingles-playing with words Give people a funny nickname Use of colorful words, phrases when talking Imitate how others talk Write words to song, poetry Write story to songs Make up odd scary exciting story Telling stories about favorite movie book Looking up words in dictionary Writing reports Writing notes, make checklists to do, detailed notes, write letter Make up abbreviations memorable Explain-teach to someone Tape record and review it Convincing speaker-public speaking, talks to groups Bargaining, making a deal Managing, supervising people		*Exceeds providing outstanding effective examples of having the learner think in words and to use language to express and understand meaning. Sensitive to meaning of words, sounds, rhythms and inflections.*	*Appropriate use of MI strategies or activities. Provides good examples of having the learner think in words and to use language to express and understand meaning. Sensitive to meaning of words, sounds, rhythms and inflections.*	*Displays general understanding of integrating MI activities. Provides some fair examples to have the learner think in words and to use language to express and understand meaning. Sensitive to meaning of words, sounds, rhythms and inflections.*	*Lacks MI strategies or activities. Provides no examples to have the learner think in words and to use language to express and understand meaning. Sensitive to meaning of words, sounds, rhythms and inflections.*
To have the learner think in words and to use language to express and under-stand meaning. Sensitive to meaning of words, sounds, rhythms and inflections	Content-MI Strategies: Expressive sensitivity: -careful use of language for communication and expression -primarily oral Rhetorical skill: -uses language effectively for negotiation, persuasion Written-Academic ability: -words used well in writing story, letter, report -use of verbal memory, reading, writing	_______ _______ _______ _______ _______	_______ _______ _______ _______ _______	_______ _______ _______ _______ _______	_______ _______ _______ _______ _______
TOTAL	(Possible 15 points)				

6. **MI Intelligence**	**CBT content/skills- Provides examples and shows evidence of effectively using:**	**Significant Evidence (3)**	**Good Evidence (2)**	**Some Evidence (1)**	**No Evidence (0)**
INTERPERSONAL Sample Activities: Group study Family discussions Listen to learn activity Create lesson plan to teach it to someone Team leadership-help other settle argument, make peace, solve a problem between two people Recognize faces, voices Interacting effectively Plan a meeting Learn conflict resolution skills Observe children and describe their feelings Volunteer at a nursing home or hospital		*Exceeds providing outstanding effective examples of having the learner think about, listen, understand and know another person and other people.*	*Appropriate use of MI strategies or activities. Provides good examples of having the learner think about, listen, understand and know another person and other people*	*Displays general understanding of integrating MI activities. Provides some fair examples to have the learner think about, listen, understand and know another person and other people.*	*Lacks MI strategies or activities. Provides no examples to have the learner* think *about, listen, understand and know another person and other people.*
To have the learner think about, listen, understand and know another person and other people	Content-MI Strategies: Social sensitivity -aware and concerned about others -socially astute Social persuasion: -able to influence others Interpersonal work: -people oriented work	_______ _______ _______ _______	_______ _______ _______ _______	_______ _______ _______ _______	_______ _______ _______ _______
TOTAL	(Possible 12 points)				

7. **MI Intelligence**	**CBT content/skills-Provides examples and shows evidence of effectively using:**	**Significant Evidence (3)**	**Good Evidence (2)**	**Some Evidence (1)**	**No Evidence (0)**
INTRAPERSONAL Sample Activities: Reflections and monitoring ones thoughts and feelings Keep a diary Write timeline of ones life Make future plans Design an advertisement for oneself Goal setting		*Exceeds providing outstanding effective examples of having the learner think about and understand one's self. To be aware of ones strengths, weak-nesses, plans and goals.*	*Appropriate use of MI strategies or activities. Provides good examples of having the learner think about and understand one's self. To be aware of ones strengths, weaknesses plans and goals.*	*Displays general understanding of integrating MI activities. Provides some fair examples to have the learner think about and understand one's self. To be aware of ones strengths, weaknesses, plans and goals.*	*Lacks MI strategies or activities. Provides no examples to have the learner think about and nder-stand one's self. To be aware of ones strengths, weak-nesses, plans and goals.*
To have the learner think about and under-stand one's self. To be aware of ones strength, weakness, plan and goals.	Content-MI Strategies: Personal knowledge, efficacy: -aware of own strengths	_______	_______	_______	_______
	Self, other effectiveness -get along with others	_______	_______	_______	_______
	Calculations: -metacognition-thinking about thinking, logical reasoning	_______	_______	_______	_______
	Spatial problem solving: -problem solve while moving objects through space	_______	_______	_______	_______
	-mental imagery	_______	_______	_______	_______
TOTAL	(Possible 15 points)				
8. **MI Intelligence**	**CBT content/skills-Provides examples and shows evidence of effectively using:**	**Significant Evidence (3)**	**Good Evidence (2)**	**Some Evidence (1)**	**No Evidence (0)**

NATURALISTIC Sample Activities: Work with plants-gardening, farming, horticulture Work with animals-behavior, needs, care, breeding, training Work with natural living energy forces-ex. Cooking, weather, physics Observations-identify patterns Conduct survey of wildlife in neighborhood Record, organize data Chart weather Raise or study tropical fish, birds Collect insects		*Exceeds providing outstanding effective examples of having the learner understand the natural world including plants, animals and scientific studies.*	*Appropriate use of MI strategies or activities. Provides good examples of having the learner understand the natural world including plants, animals and scientific studies.*	*Displays general understanding of integrating MI activities. Provides some fair examples to have the learner understand the natural world including plants, animals and scientific studies*	*Lacks MI strategies or activities. Provides no examples to have the learner under-stand the natural world including plants, animals and scientific studies.*
To have the learner under-stand the natural world including plants, animals and scientific studies	Content-MI Strategies: Animal care: -understanding, working and caring for animals Plant care: -understanding how to care for plants Science: -involvement in science scientific-type inquiry	_______ _______ _______	_______ _______ _______	_______ _______ _______	_______ _______ _______
TOTAL	(Possible 9 points)				

Appendix P

Definition of Terms

Computer-Assisted Instruction (CAI)—The use of computers to present instruction to students.

Computer-Aided Instruction (CAI)—A method of independent learning using a personal computer to present material and guide the learner through a lesson, allowing freedom of navigation choice, and providing the ability to bypass material already mastered.

Computer-Based Instruction (CBI)—see Computer-Based Training.

Computer-Based Training (CBT)—also known as Computer-Based Instruction (CBI). Computer-Based Training is any training that uses a computer as the focal point for instructional delivery. With CBTs, training is provided through the use of a computer and software which guides a learner through an instructional program. This technology tool can be saved as a self-running CD or it can be embedded into a website. CBTs are designed to use a computer to provide interactive education.

Concept maps—Graphical representations of concepts and their interconnections. They are schematic devices for representing conceptual understanding (Burke, 1998).

Constructivism—A dynamic learning process of helping learners to construct their own meaning from their experiences. A constructivist theory supports learning as knowledge is gained through interactions with the environment.

Coefficient of Determination (R^2)—This is the correlation coefficient (r) score that must be squared to get rid of a negative correlation coefficient and its a squared correlation coefficient for accurately predicting how one variable can predict the other and it measures the strength of a relationship to predict the relationship between two variables from 0 to 1 to indicate how much the independent variable influences the dependent variable. In other words, it measures the proportion of variance in one variable that can be predicted on the basis of using its relationship with the other variable. In other words, .5 squared = .25 or 25% accuracy.

Correlation coefficients (r)—This indicates the level of linear correlation between two independent variables. The scale is always a number between +1 and -1; with 1 indicating a high perfect positive linear correlation and a -1 indicating a perfect negative linear correlation. If it is closer to -1, then the relationship is weaker; if it's closer to +1, then the relationship is stronger between 2 variables. Also, +1 indicates a relationship, correlation, or predictability between two variables with a 100% perfectly predictable relationship, meaning that the prediction is accurate 100% of the time. On the contrary, a correlation score of r = 0 indicates no linear relationship, correlation, or predictability between two independent variables. Despite a correlation coefficient (r) score of r = .50 or 50%, which indicates a moderate positive linear correlation, one cannot make predictions with 50% accuracy because the score must be squared for accurately predicting how one variable can predict the other. In other words, .5 squared = .25 or 25% accuracy.

Designed-based research—"[A] systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories" (Wang & Hannafin, 2005, p. 6).

Intelligence—Dr. C. Branton Shearer (2008), on his Web site, gives the definition of intelligence used by Howard Gardner: "the ability to solve a problem or create a product that is valued within one or more cultures." Intelligence also represents the type of intelligence the study in question is making use of (based on Gardner's theory of multiple intelligences; see *MI*). Fanelli (1998) notes that this definition has nothing to do with numbers such as IQ, GPA or SATs.

Interface design—The text and graphic arrangement on a computer screen or window.

Learning styles—The various ways in which individuals prefer to learn, such as audio, visual, tactile, and kinesthetic.

Multiple Intelligences (MI)—The various ways that individuals are intelligent and acquire new knowledge. See definitions of each below.

MI—Definition of Terms (Ford, 2000, pp. 24-25):

Bodily-kinesthetic: The ability to use the body skillfully and handle objects.

Interpersonal: The ability to understand people and relationships. The ability to read people, sensitivity to moods, motivations and feelings of others.

Intrapersonal: The ability to perceive the world accurately and to recreate or transform aspects of that world.

Logical-mathematical: The ability to use numbers effectively, logically sequence categorization, inference and other related abstractions.

Naturalistic: The ability to appreciate and recognize the natural world. Capacities include species discernment and discrimination, recognition and classification of plants and general knowledge of the natural world.

Rhythmic-musical: The ability to perceive or express musical forms. Sensitivity to pitch, melody, rhythm and tone.

Verbal-linguistic: The person demonstrates personal sensitivity and ability toward the meaning and order of words. The capacity to effectively use words both orally and written.

Visual-spatial: The ability to perceive the visual-spatial world accurately and to perform transformations on those perceptions.

Multiple Intelligences Development Assessment Scales (MIDAS)—A test authored by C. Branton Shearer and intended as a screening instrument to determine the characteristics of an individual's multiple intelligences (MI) disposition. It is “designed for the purpose to provide an objective measure of the multiple intelligences” (Shearer, 2008, para. 2). It is based on Howard Gardner's theory of MI.

MI Theory (MI)—Dr. Howard Gardner's theory of intelligence as published in his book *Frames of Mind* in 1983. Dr. Gardner defined this theory as "a biopsychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture-these potentials are represented in varying degrees by the following eight intelligences: verbal-linguistic, logical-mathematical, bodily-kinesthetic, rhythmic-musical, visual-spatial, naturalistic, interpersonal and intrapersonal" (as cited in Marsland, 2000, p. 15).

Nodes— a window or a message box on a computer screen with links, such as buttons, menus, etc., that enable a user to navigate from screens to different paths in order to seek and change information on a screen.

Scaffolding— “[T]he process by which an expert supports a learner in executing a complex task—has proven successful in a variety of environments, for a variety of learning goals, and for diverse student populations” (Sharma & Hannafin, 2004, p. 184).

Significant F (p-value)—This is a measure of the extent to which a variable makes a unique contribution to the prediction. When you run a regression, the coefficient associated with your independent variable tells you the magnitude and direction of that variable's impact on your dependent variable.

Web-based Distance Learning (WBDL)—The combination of Computer-Based Training and distance learning that is a resource to provide opportunities for training and development needs of organizations and distance learners (Long & Smith 2004).

Appendix Q

Summary Description of Each Type of Qualitative Data Features Collected

TEXT DENSITY: (see Appendix F) number of all of the words counted in the body of each screen (text labels or menu items not included).

PROGRAM LENGTH: (see Appendix F) number of screens in program.

MEDIA: (see Appendix G) total number of all media elements, which include graphic buttons, graphics/images, sound, video, and animation/transitions.

Graphic Buttons: total number of graphic buttons made by the designer (text on some)

Graphics/Images (Pictures, Charts): total number of graphics and images counted (excluding text graphic buttons)

Sound: total number of sounds including voice, sound effects, and music. If a video had sound, it was counted as video but its sound was also counted as a sound.

Video: total number of videos.

Animation and Transitions: total number of animations (moving objects) and screen transitions.

INTERACTIONS: (see Appendix I) total number of interactions counted for the following:

Click: total number of mouse clicks on each screen with the right answer counted

Drag: total number counted of the times to drag an item to the correct answer over a touch target/hot spot area

Press: total number of times counted for one to keypress ones response or answer for multiple choice or true/false quiz questions

Feedback: total number of times counted when designer responded back to quiz answers.

Response Tries Limit: total number of times counted on each screen for quiz questions with a limited number of times to try to answer a question

Response Time Limit: total number of times counted on each screen with a time limit to respond to a question

Text Entry: total number of times counted on each screen to fill in the blank answer

NAVIGATION: (see Appendix K) total number on each screen with the following buttons:

Quit: total number of buttons to quit

Go Back to Previous Screen: total number of buttons to go back to previous screen

Quiz: total number of quiz buttons

On Screen: total number of buttons in the On Screen Menu

Pull Down Menu's: total number of buttons in the Pull Down Menu bar

Continue or Forward (Pacing): total number of times counted on each screen with a continue button to move forward (ex. next)

Go Back to Main Menu: total number of buttons to go back to the Main Menu

NODES: (see Appendix J) total number of all of the nodes for the depth of the navigation counted

LEVELS: (see Appendix J) total number of all levels for the depth of one to eight levels.