CHARACTERISTICS OF SUCCESSFUL AND UNSUCCESSFUL TECHNICAL COLLEGE STUDENTS IN ONLINE AND FACE-TO-FACE MATHEMATICS CLASSES

by

PAUL WAYNE GODFREY

(Under the Direction of Roger B. Hill)

ABSTRACT

This was a study of the preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency of students enrolled in basic mathematics classes at a medium-size technical college in Georgia. The study compared these characteristics for successful and unsuccessful students who self-selected one of two course delivery formats, online and face-to-face, for a basic mathematics class. This study included 288 students from the five campuses of a selected college. The measures of the four characteristics were collected for each combination of class format and success outcome. Two-way analyses of variance found that class format and success status relative to the measured characteristics individually did not produce significant results.

INDEX WORDS: Online, Face-to-face, Learning styles, Technical College, Mathematics

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DEDICATION

This study is dedicated to my father Tharo Belton Godfrey who died before the study could be complete. He was my HERO.

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CHAPTER 1

INTRODUCTION

Background

Use of the Internet to deliver instruction and manage learning activities is "widespread and rapidly growing" (Dutton, Dutton, & Perry, 2002, p. 1). In addition to traditional face-to-face classes, the Technical College System of Georgia (TCSG), through the Georgia Virtual Technical College (GVTC) has identified three categories of Internet use in connection with classes: online, hybrid, and Web-enhanced (Georgia Virtual Technical College, 2002). Face-to-face classes are conducted predominately with personal interaction in real life as opposed to via digital or electronic communications medium (Texas A&M University, 2008). Web-enhanced courses are traditional classroom courses that use the Internet as an important component of the course. Students may complete assignments or take tests online as a complement to the classroom experience. "Hybrid courses are classes that are taught partially via the Internet and partially via the classroom. Hybrid courses differ from Web-enhanced courses in that Web-enhanced courses are assigned to a classroom for every contact hour described in the course catalog" (GVTC, p. 5). Both of these have significant face-to-face components. However, for a course offered in the online format using the Internet as a medium, the GVTC Quality Assurance of Online Courses Manual (2003) specifies, "the course is taught totally online" (p. 4).

The use of the Internet as a medium for college-level education has increased at a fast pace during this decade. Thousands of university courses have been developed for course delivery entirely via the Internet (Hopper & Harmon, 2000). The use of online classes has rapidly expanded over the last several years (Allen & Seaman, 2004). "Over 1.6 million students took at least one online course during Fall 2002" (Allen & Seaman, 2003, p. 1). "This trend will only accelerate as more colleges and universities urge faculty to create online versions of their courses" (Dutton et al., 2002, p. 1). In the fall of 2003, over 1.9 million students took at least one on-line class. Allen and Seaman (2004) projected that that number would increase to 2.6 million by 2004. Allen and Seaman (2008) reported, "Almost 3.5 million students were taking at least one online course during the fall 2006 term" (p. 1). Based on exponential growth projected by these values, over 5 million students can be expected to take at least one on-line course in 2008 and 6 million in 2009.

Within the Technical College System of Georgia (TCSG), the asynchronous learning format for course delivery using the Internet, a component of online education, makes attending classes for the primarily adult student population of Georgia's Technical Colleges more convenient than attending traditional or hybrid classes. This convenience in taking classes results in an increased likelihood that students will chose an online class over a face-to-face class where the choice is available. The TCSG has provided students that choice by offering more and more classes over the Internet. In the past few years the Georgia Virtual Technical College (GVTC), through which the various colleges offer these online courses, has significantly increased the variety and quantity of their online offerings (GVTC, 2008). For example, in 2003, no associate-level mathematics classes were offered online. By winter quarter of 2005, GVTC offered 80 of these courses online, and by spring of 2008, students could choose from 111 mathematics classes. It is now possible to earn an associate's degree almost entirely online.

The GVTC served more than 40,000 students in 2005, or about 10,000 students per quarter (Technical College Directors' Association of Georgia, 2005). By the fall of 2008, the enrollment was 20,694 students (GVTC, 2008). GVTC has defined an online program as consisting of “the procedures, courses, and programs offered by a technical college over the Internet to develop competencies for a specific occupation” (GVTC, 2002, p. 94). GVTC defined the individual courses offered as part of this program as online courses (GVTC, 2009a). These online courses may be either asynchronous, synchronous, or a combination of the two. In its faculty online Web page explaining online instruction, GVTC (2003) provided the following statement.

> In both modes of online learning environments, students are not bound by "space" (unless the course requires on-campus attendance). The primary form of delivery for online instruction at GVTC is via the World Wide Web within our courseware product … [and] dependant [sic] upon how the instructor designs the course, students may and eventually will be required to submit and participate in course requirements that are subject to specific time frames (synchronous). Having students participate in an online chat environment is an example of a "synchronous" environment in which students ARE required to participate in [sic] and be at a specific place at a specific time. Although GVTC recognizes that, at some points in a course, there may be some "synchronous" requirements, the goal is to make the courses that are designed by GVTC instructors and staff as asynchronous as possible. (p. 1)

Thus, the predominant online technical college class is asynchronous.

Allen and Seaman (2004) identified three types of online structures, “Web courses which present material with little or no interaction, Web-enhanced courses consisting of a hybrid of face-to-face and online, and Web-centric which are interactive courses conducted exclusively using a course site” (p. 254). In addition to purely online classes, GVTC has allowed the enhancement or hybridization of the traditional face-to-face class structure with an Internet component (GVTC, 2009a). Within GVTC, this can take many forms ranging from using the Internet as a location for posting syllabi and assignments, to using the Internet for automated testing, to delivering portions of the class content via the World Wide Web. However, each of these combinations is grounded in the classroom.

Allen and Seaman (2003) characterized these varying degrees of combination as Web-enhanced, blended, or hybrid. Describing a Web-enhanced class, Allen and Seaman described a Web-enhanced course as a "course which uses Web-based technology to facilitate what is essentially a face-to-face course" (p. 6). They said these courses "might use Blackboard or WebCT to post the syllabus and assignments, for example" (p. 6). Allen and Seaman defined a blended or hybrid as a "course that is a blend of the online and face-to-face course. [A] substantial proportion of the content is delivered online, typically uses online discussions, [and] typically has some face-to-face meetings" (p. 6). In each case, however, the student is tied to the classroom by time and place requirements of physical attendance.

Purely online asynchronous courses do not have this grounded component. This makes attending classes for the primarily adult student population, many of whom may be full-time employed, more convenient than attending either purely face-to-face classes or their hybrid incarnations, especially since they are not as time and place dependent as their face-to-face counterparts. Grandon, Alshare, and Kwun, (2005) have found that, in the United States, the decision to take online or face-to-face classes is made principally based on convenience and perceived ease of use.

There are differences between face-to-face and online classes besides the convenience and ease of use factors, although some think the only difference between the two types of delivery is the medium. In reviews of 28 research studies of online learning, Sunal, Sunal, Odell, and Sundberg (2003) noted that online classes are designed either to transfer the face-to-face experience to the online environment or to redesign the class for the online environment. For those who attempted to replicate the face-to-face class as an online class, the assumption was the learning that the course structure facilitated was not affected by the delivery media (Joy & Garcia, 2000). That is, the online class could be merely an emulation of the face-to-face structure because "research supports the idea that media, per se, do not influence learning" (Sunal et al., p. 16). For example, in their survey of e-learning in colleges across the nation, Zemsky and Massey (2004) found that: "For the most part, faculty who make e-learning a part of their teaching do so by having the electronics simplify tasks, not by fundamentally changing how the subject is taught" (p. 52). That is, they found that faculty delivered the same timeworn content, changing only the media of delivery.

Others believe that there should be a difference in the structure of the delivered content. Zemsky and Massey (2004) said, "The marriage of new electronic technologies and newly accepted theories of learning promised to yield a revolution in pedagogy itself" (p. 1). For those who attempted to redesign the class for online, the assumption was that learning took place differently in an online class. For example, Swan (2003) explained, "Early research on asynchronous online learning has shown that the structure, transparency, and communication potential of course designs heavily impact students' learning" (p. 7). Swan examined 73 different online courses and "found significant correlations between the clarity, consistency, and simplicity of course designs and students' perceived learning" (p. 7).

Regardless of the approach taken, i.e., whether students learn the same way in online classes as in face-to-face classes or whether student learning in online classes differs from that of face-to-face, the Western Cooperative for Educational Telecommunications (WCET) found most studies to date reflected no significant difference in constructs being analyzed between face-to-face and online classes (2006). The WCET online database identified 23 studies comparing online classes to face-to-face classes that found no significant differences between the two. Specific comparisons of online and face-to-face classes in mathematics have come to the same conclusion (Mascuilli, 2004). This would appear to support a contention that learning takes place in the same way for each. For technical colleges in Georgia this bodes well, considering the investment in online classes outlined above.

The WCET (2006) database also identified nine studies that did find significant differences, with online class results surpassing face-to-face class results. In addition, Zemsky and Massey (2004) found that "the most successful forms of e-learning are the courses delivered on the Internet - courses that teach a particular subject; courses that are part of a degree program most often at the graduate or professional level; and, finally, courses that offer certification in a vocational or technical skill" (p. 5). These findings on successful forms of e-learning are encouraging to faculty and administrators in the TCSG, with its over 40,000 students served by online classes, because it provides adults in the work force the ability to obtain an up-to-date technical education by means which are neither time nor place dependent.

Asunda and Hill (2007), in discussing the critical features of engineering design, identified "using mathematical principles to optimize for best and possible solutions" (p. 36). They identified the iterative process of engineering design as significant in technology education instruction. One of the essential content areas within the technical college programs of study is the mathematics component known as numeracy. Numeracy is the knowledge of basic number skills and the ability to apply those skills in contexts that require high levels of literacy to interpret situations and make judgments (Steen, 2001). "Virtually everyone uses quantitative tools in some way in relation to their work, if only to calculate their wages and benefits (Steen, p. 1).

Many instances of numeracy are very specific to the particular work environment, but some are not. Steen (2001) provided specific examples.

> Examples of numeracy on the job are [.…] producing a schedule or tree diagram for a complicated project; looking up, interpreting, and using work-related formulas; using spreadsheets to model different scenarios for product sales and preparing graphs that illustrate these options; understanding and using exponential notation and logarithmic scales of measurement; maintaining and using quality control charts; optimizing networks to discover efficient ways to plan work processes; [and] understanding the value of statistical quality control and statistical process control. (p. 1)

Clearly, numeracy - that is, basic mathematics training - is important to a technical education. Indeed, it is a component of every diploma or degree offered by the TCSG. Technical college students, who are predominantly adults, must learn mathematics. The choice of a mathematics class for TCSG students is limited to three at the diploma level. First is a business mathematics class (MAT 1011 Business Mathematics) for the students in a business field (about 13% of all students). Second, for those in a computer, drafting, or electronics field (about 10% of all students) there is an algebraic concepts class (MAT 1013 Algebraic Concepts). Finally, for all others (about 77% of all students) there is a basic mathematics class (MAT 1012 Foundations of Mathematics) (Lanier Technical College, 2008). As diploma level students comprise over 80% of the fulltime student population, a significant majority of students take the MAT 1012 class.

Whichever class the TCSG student takes, she or he can chose to learn mathematics exclusively in the face-to-face class format. However, with the growing use of online classes in technical colleges, many technical college students can be expected to learn mathematics in the online class format. For the workforce education establishment that increasingly relies on these online classes, it has become crucial to determine if student characteristics are related to success in the class format for learning selected by the technical college student.

Not much research has been done in this area. In fact, Engelbrecht and Harding (2005a) said the little research done on online mathematics classes is mainly in the form of case studies with few quantitative comparative studies of significance. Of those studies related to online mathematics, the principal areas investigated have been teacher preparedness (Pankowski, 2003), design of materials for teaching numeracy online (Fitzsimons, 2002), and assessment (Engelbrecht & Harding, 2004).

On the other hand, many studies have been conducted investigating how adults go about learning mathematics in the classroom. Condelli, Safford-Ramus, Sherman, Coben, Gal, and Hector-Mason (2006) identified over 140 dissertations related to this topic from 1980 to 2005. These methods vary from strict constructivism, which focuses almost exclusively on acquisition of conceptual knowledge and problem solving internal to the individual (Baroody & Dowker, 2003), to situated learning, which contends that learning is situational, and therefore externally, dependent (Anderson, Reder, & Simon, 2000), to rote drill, which is in essence learning through repetition. These dissertation studies also ranged from investigation of individual endeavor to investigation of group social perception. Anderson et al. (2000) conducted a critical analysis of various approaches to learning in mathematics. They looked at opinions and observations in both situated learning and constructivism in mathematics education, found agreements and disagreements between these two approaches, and championed an information-processing approach as needed to help different people learn mathematics in different ways.

Intelligence may arguably be the primary factor in a student's ability to learn mathematics. Gardner (1983) proposed an initial list of seven intelligences: linguistic, logical-mathematical, musical, bodily-kinesthetic, spatial, interpersonal, and intrapersonal. Later work by Gardner and others suggested there may be as many as 10 (Smith, 2002). "Subsequent research and reflection by Howard Gardner and his colleagues has looked to three particular possibilities: a naturalist intelligence, a spiritual intelligence, and an existential intelligence" (Smith, p. 1). Research has shown that people have different preferred learning styles based on these multiple intelligences (Gardner, 1999). One identified underlying factor in how adults learn mathematics is their learning style (Skinner, 1990). Thus, in understanding how adult technical college students learn mathematics online, one critical factor to assess is the students' preferred learning styles. Cognitive learning style has been identified as a major factor in predicting the success of a student in a general online environment (Chen & Liu, 2008).

Various tools are currently in use to assess readiness for online learning or to predict success in online learning. For example, the University System of Georgia (USG) uses the Student Online Readiness Tool (SORT) (Board of Regents of the University System of Georgia, 2003) to help students decide if they are ready for online classes. The SORT evaluates the six topical areas of technology experience, access to tools, study habits, lifestyle, goals and purposes, and learning preference.

The Technical College System of Georgia (TCSG) uses an evaluation instrument known as the Readiness for Education at a Distance Indicator (READI) (GVTC, 2009b). Preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency are among the component factors evaluated by this measurement tool. Thus, the existence of differences in preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency among students have been identified by prior research and officially recognized as measurable by the use of READI within the TCSG in conjunction with their online classes (GVTC, 2009b).

Definitions

Face-to-face classes. Classes that are conducted predominately with personal interaction in real life as opposed to via digital or electronic communications medium (Texas A&M University, 2008).

Occupational program. A Technical College System of Georgia (TCSG) curriculum program that is standardized, and is based on business and industry requirements across the state. Standards are designed to prepare students for careers in specific professions (TCSG, 2009a).

Online class. A course offered in the online format using the Internet as a medium. Within the TCSG, this is a course taught totally online and as asynchronous as possible (GVTC, 2003).

Successful. A characterization of student achievement in a course whereby the student may transfer credit for the class to any college in the TCSG. Based on the standardized TCSG grading scale this equates to a C in the course (TCSG, 2008c)

Purpose of the Study

The purpose of this study was to examine the differences in preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency of technical college mathematics students in a basic mathematics class (MAT 1012 Foundations of Mathematics) and to ascertain the extent of differences among the successful and unsuccessful students in both face-to-face and online classes. In the context of this study, an online class was one where all instruction and assigned work was managed using the Internet, and a face-to-face class was one in which students reported to a physical classroom for traditional instruction, which might have included Web-enhanced or hybrid Internet components.

Although large volumes of studies indicated no significant difference in outcomes between online and face-to-face delivery, that research continues to be questioned (Clark, 1994; Joy & Garcia, 2000; Kassop, 2003; Kozma, 1994a; Sangster, 1999, Sahin, 2006; Sitzmann, Kraiger, Stewart, Wisher, 2006; & Ferguson & Tryjankowski, 2009). One such critique centered on the lack of consideration in the research of the individual student's characteristics and the role these characteristics played in online learning. Robinson (2004) studied student characteristics as they related to satisfaction with their online course experience and developed an objective measuring instrument to determine that satisfaction. While some studies have shown individual student characteristics can predict success in online classes, most have primarily focused on previous student grade point averages and demographic factors as predictors of success (Wojciechowski & Palmer, 2005). On the other hand, research by Hartman in 2001 identified various individual attributes that are significant predictors of success in an online learning environment. Other research has identified readiness as a strong predictor of success in online courses (Smith, 2005; Smith, Murphy, & Mahoney, 2003). However, a variable, largely unexamined, is the possibility of differences between the characteristics and attributes of successful and unsuccessful students in both online and face-to-face classes.

Addressing differences in preferences of online and face-to-face students, Engelbrecht and Harding (2005b) reported, "More visually inclined learners tend to prefer the use of technology, while more verbal learners preferred a face-to-face learning environment" (p. 13). Given the research showing that different people learn mathematics in the face-to-face classroom in different ways (Anderson et al., 2000), it is reasonable to surmise that students who are successful in learning in online mathematics classes and those who are successful in learning in face-to-face mathematics classes may exhibit different characteristics and attributes. In fact, at least some researchers in mathematics education have said, “Only students that are strongly motivated self-starters, intellectually mature, home-schooled, or the handicapped can successfully complete the on-line mathematics course” (Engelbrecht & Harding, p. 13).

While the lack of difference in outcomes of face-to-face and online mathematics classes have been touted, whether there are differences in characteristics of the successful and unsuccessful students in both formats has not been ascertained. In a preliminary analysis of the influence of learning style preferences on student success, Aragon, Johnson, and Shaik (2002) concluded there were significant variances in the learning style preferences of face-to-face and online students. As cited above, some believe these differences must also exist between successful and unsuccessful students. The problem is that there has been no determination as to whether these differences in characteristics of successful and unsuccessful students in both online and face-to face basic mathematics classes actually do exist.

Research Questions

The following questions guided this research:

1. Are there statistically significant differences in the preferred learning styles of successful and unsuccessful face-to-face and online students in a basic mathematics course?

2. Is there a statistically significant difference in the computer information system competency of successful and unsuccessful face-to-face and online students in a basic mathematics course?

3. Is there a statistically significant difference in the on-screen reading ability of successful and unsuccessful face-to-face and online students in a basic mathematics course?

4. Is there a statistically significant difference in the keyboarding proficiency of successful and unsuccessful face-to-face and online students in a basic mathematics course?

Theoretical Framework

The instrument used in this study was the Readiness for Education at a Distance Indicator (READI). It is based on two principal learning theories: learning styles theory and the theory of multiple intelligences (Decade Consulting, 2009b). While these two theories are different, in application, they are learner-centered and their outcomes are similar (Katzowitz, 2002).

Learning styles theory clearly informs us to expect differences in learning style preferences from individual to individual (Katzowitz, 2002). Since learning style preferences define the way individuals seek to extract, process, and memorize information, they are particularly important in Web-based learning (Brown, Stothers, Thorp, & Ingram, 2006). There are various learning style models. Felder (1996) cited four learning style models that have been effectively used in engineering education. The Myers-Briggs Type Indicator (MBTI) was based on scales derived from psychologist Carl Jung's theory of psychological types and classified students according to their preference on this scale. Kolb's Learning Style Model classifies students as having either concrete experience or abstract conceptualization and either active experimentation or reflective observation. The Herrmann Brain Dominance Instrument (HBDI) classifies students in one of four different modes based on the task-specialized functioning of the physical brain in terms of their relative preferences for thinking. The Felder-Silverman Learning Style Model classifies students as sensing learners, visual learners, or verbal learners; inductive learners or deductive learners; active learners or reflective learners; and sequential learners or global learners.

The learning style model used by the READI instrument is based on is the Memletics model (Decade Consulting, 2009a). This model provides a specific numeric measure for each of seven areas: visual (spatial), aural (auditory-musical), verbal (linguistic), physical (kinesthetic), logical (mathematical), social (interpersonal), and solitary (intrapersonal) (Advanogy, 2007b). Learning style is one of several components of the READI used to determine the readiness for technical college students to succeed in an online program (GVTC, 2008). Katzowitz (2002) explained

> Although most people can learn in a variety of ways - even in nonpreferred ways, each has their own preferred way, i.e., the way that is easiest to learn (Dunn, 1996). Some students like to focus on facts and algorithms, but others are better suited to math and theories. There are students who respond better to visual information, such as pictures, charts, and diagrams. Others learn more linguistically-written and spoken explanations. Some students learn actively and do well in a cooperative group, and others prefer to work individually (Felder, 1996). (p. 6)

Felder (1996) explained that for different classes there are differences in class settings. The setting may favor a student's less preferred learning style causing the student discomfort so great as to interfere with their learning. "On the other hand, if professors teach exclusively in their students' preferred modes, the students may not develop the mental dexterity they need to reach their potential for achievement in school and as professionals" (p. 1). Thus, we would expect to encounter differences in learning styles associated with success in different class formats, such as the online and face-to-face class formats, where teaching modes are clearly different.

Multiple intelligences theory also tells us to expect that people with differing intelligences may express preference for differing styles of learning (Gardner, 2006). In addition, research by Laughlin (1999) detailed differing characteristics that were observed in students exhibiting a propensity for one of the multiple intelligences identified by Gardner, and the implications of these differences had for learning and instruction. In addition, Smith (2006), in relation to digital libraries, suggested that multiple intelligences theory informs us about differences that may be encountered in the information technology arena.

From the definitions of Gardner's seven intelligences in Appendix A, the characteristics of multiple intelligences set forth by Laughlin in Appendix B, and the evidence of the relationship of multiple intelligences with technology identified by Smith, the area of computer information system competency is recognizable as related to logical/mathematical and bodily/kinesthetic intelligence. Likewise, on-screen reading ability can be seen as related to visual/spatial and verbal/linguistic intelligence. Finally, keyboarding proficiency is clearly related to visual/spatial and bodily/kinesthetic.

The READI provided a numeric measure of the four areas identified in the research questions. These areas are preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency.

Preferred Learning Styles

Preferred learning styles are simply different approaches or ways of learning. Decade Consulting identified the types of learning styles as visual learners, auditory learners, kinesthetic learners, and tactile/kinesthetic learners (2009b). Preferred learning styles are those learning styles a particular person prefers be employed for their reception of information. Kolb (2008) said preferred learning styles are an aspect of peoples' preferred ways of adapting in the world. The preferred learning styles measures embedded in the READI instrument is adapted from the Memletics preferred learning styles instrument and is grounded in multiple intelligences research (Decade Consulting).

In their report on best practices for developing online classes, Sunal, Sunal, Odell, and Sundberg (2003) identified preferred learning styles as one of the factors that influenced student achievement in Web-based courses. Sunal et al. (2003) said, "Identifying students' preferred learning styles could allow teachers to have a deeper appreciation of how learners perceive and process information in different ways" (p. 6). They also examined how students' learning strategies, patterns of learning, and achievement differed in relation to their preferred learning styles and the relationship among these three factors and selected variables. Sunal et al. said that it appears that an understanding of techniques and skills used by students in accomplishing a learning task would be helpful. The value that knowledge of learning strategies gives is that "it may be difficult for students to change their preferred learning styles, but their learning strategies might be controlled and changed through teaching" (Sunal et al., p. 7). This seems to make examining learning factors, such as preferred learning styles, that affect student achievement in Web-based instruction essential. On the other hand, Aragon, Johnson, and Shaik (2002) advised that in their study, "Correlations between learning style and course performance were not found for the online students" (p. 15).

Computer Information Systems Competency

Computer information systems competency is a measure of basic technology skills such as the ability to use a laptop, printer, software, and the Internet technology in an instructional environment (Decade Consulting, 2009b). While technology can be useful in aiding the learner, such as in the accommodation of different preferred learning styles and preferences, including disabilities, inability to use that technology abrogates gains that may be possible (Fahy, 2004). The READI provides a measure of the student's technical knowledge and competence with computer information systems (Decade Consulting, 2009c). Fahy reported that the "fear felt by users (staff and learners) over the level of technical knowledge required to get involved" in the multimedia of online learning is a major obstacle (p. 162). "Many users (teachers, trainers, and learners) feel they do not have all the skills they need to make mature use of online learning's potential" (p. 166). Fahy said that these limitations "may account for some of the increasing class of former users called 'Internet dropouts'" (p. 165). On the other hand, DeTure (2004) reported that "online technologies self-efficacy scores were poor predictors of student success in online distance education" (p. 1).

Reading Comprehension

When a substantial amount of reading is required in a class, the ability to read and comprehend what is read is clearly an important characteristic of a student. This is just as true in an online class as it is in a face-to-face class. The principal difference is that reading in online classes tends to be from a computer screen. "Both reading speed and recall are measured in READI because students should realize that they must not too rapidly read on-screen course content because they may be assessed on the content in their courses" (Decade Consulting, 2009a). In reviewing research comparing on-screen to paper, Dillon (1992) said there is a distinction "between assessing reading behaviour [sic] in terms of outcome and process measures (Schumacher & Waller 1985)" (p. 3). Outcome (comprehension) is what a reader gets from the text and relates to the "amount of information retrieved, accuracy of recall, time taken to read the text and so forth" (Dillon, p. 3). Process (speed) is concerned with "how the reader uses a text and includes such variables as where the reader looks in the text and how s/he manipulates it" (Dillon, p. 3). Dillon explained:

> In the domain of electronic text, outcome measures take on a particular relevance as advocates proclaim increased efficiency and improved performance (i.e., outcomes) with computer presented material (aspects of direct concern to ergonomists). It is not surprising therefore to find that the majority of work comparing the two media has concentrated heavily on such differences. With the emergence of hypertext however, navigation has become a major issue and process measures are gaining increased recognition of importance. (p. 3)

Dillon (1992) found that reading from a screen is significantly slower than reading from paper, while accuracy in what is read on-screen tends to be less conclusive. Insofar as comprehension research has been conducted, Dillon reported it has been inconclusive. However, given the slight edge reading from paper appears to enjoy, a facility for on-screen reading and comprehension may bode well for success in online courses.

Keyboarding Proficiency

Another area that scholars have identified as important to learners' success in online environments is keyboarding skills (Palloff & Pratt, 1999). READI provides a measure of the students keyboarding skills (Decade Consulting, 2009c). McGrath (2003) found that low skills in this area are deleterious to a student's participation and hence learning. For example, "poor typing skills may interfere with [a student's] ability to contribute to fast-paced discussions in the chat room" (McGrath, p. 24). McGrath related:

> For students who lack typing skills, communicating in a chat room can be a frustrating experience. By the time a slower typer has composed his comment, one of his peers may have already posted a similar sentiment. Seeing that a peer has beaten him to it, the slower typer may decide not to contribute. My research suggests that this can be a serious problem. As one student wrote, "I did not participate as much as I would have like to because sometimes by the time I got finished typing what I wanted to say, someone else already said it." A few experiences like this may make the students feel isolated and weaken their motivation to contribute. (pp. 52-53)

In online classes in business, humanities, and education, typing is a principal method by which information is transmitted (Palloff & Pratt, 1999). Courses that require substantial amounts of data entry clearly require a student to be able to enter that data. A principle method for communications in online classes is by use of a keyboard; however, there is little research as to how the speed at which a student types or the accuracy of that form of data entry enhances online learning, even when the course requires substantial amounts of data entry. Nevertheless, McDonald (2002) said that in online courses "participants can more easily procrastinate in reading and/or writing, especially when the participants have limited access or low technical skills, such as slow typing speeds or are unsure of the medium" (p. 14). Hartman (2001) found that the procrastination was a significant predictor of academic performance in online courses. As to participation, McDonald cited a study by Ross (1995) that "found only a marginal effect on participation due to low technical skills" (p. 14). In addition, with the advent of grammar and spell checking software, the importance of accuracy in typing may also be less than believed.

Readiness Assessment

GVTC, in an effort at assessing the capability of students to succeed in an online class, has provided the “READI Distance Learning Readiness Assessment” for potential online students (GVTC, 2008). READI (Readiness for Education at a Distance Indicator), assesses a learner's likelihood for succeeding in an online learning program (Decade Consulting, 2009b, GVTC, 2009b). This tool consists of measurements that include the following areas: preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency. The following paragraphs summarize how these factors address readiness for learning in online classes.

The READI embodies this theoretical framework in objective measure of preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency, providing a measure of each of these areas that touch on the preparedness for success or failure in an online learning environment. These measures can also easily be used to determine the levels of these same characteristics relative to a face-to-face environment and allow for the comparison of successful and unsuccessful students in both genres.

Significance of the Study

The theoretical basis of the READI implies there is a relationship between scores in the various areas of the evaluation and preparedness to succeed in an online course. The providers of the READI asserted that it specifically assesses a “learner's likelihood for succeeding in an online learning program” (Decade Consulting, 2009b). However, it does not address the extent to which each measured construct is exclusively relevant to online instruction. This study looks at four measured constructs: preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency. In some instances, the same relationship between these factors and face-to-face classes might exist. If they do, then this tool could be a predictor of face-to-face success as well as online success. It could also be a valuable for identifying students at risk of failure in either genre. If not, then the pattern of observed characteristics may provide a measure that enables identifying in which genre a student is more likely to succeed. With increased use of distance learning and Web-based instruction, having a tool that would assist in guiding the appropriate student to the appropriate delivery method for his or her success in learning mathematics would be helpful for advising students. The instrument could also be useful in identifying students who may need remedial instruction in areas such as reading comprehension.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

This study sought to identify the differences in preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency of technical college mathematics students in a basic mathematics in both online and face-to-face formats. Using the data obtained, the study identified the extent of differences among successful and unsuccessful students in these formats. In reviewing the literature for this study, several themes emerged.

The first theme was the learning process itself. A definition of learning and a review of the various learning theories were appropriate to begin this area. This area also includes consideration of learning in workforce education and mathematics, which comprise two of the background aspects for this study.

A second theme was a consideration of learning formats. A review of online learning and a comparison of online and face-to-face learning, the two basic class formats in this study, were foundational to this study. Various areas of online learning have recently been investigated and written about in this growing part of the educational system. In addition, literature addressing the application of this research to online class design was reviewed. Finally, comparisons of online and face-to-face learning outcomes were examined.

The third theme, an important aspect of all learning, was learning readiness, and our ability to identify this readiness for an individual. This study used the readiness for education at a distance indicator (READI) to collect data about learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency. A review of the place of learning styles theory and multiple intelligences theory in this identification process is particularly germane, as these were the underlying theories of the research instrument used in this study. In addition, a review of literature relating the characteristics of computer information systems competency, on-screen reading ability, and keyboarding proficiency to learning readiness, especially in an online environment, was included.

The fourth and final theme was an appropriate research strategy that may be applied to studying the differences in characteristics among technical college students who were either successful or not successful in both face-to-face and online basic mathematics classes.

The Learning Process

"Learning is the act or process by which behavioral change, knowledge, skills, and attitudes are acquired" (Knowles, Holton, & Swanson, 1998, p. 11). Knowles et al. referred to learning as either acquiring and mastering what is already known, extending and clarifying the meaning of one's experience, or intentional and organized testing of ideas applicable to problems. In other words, it is a product, a process, or a function.

Learning theories explain how students gain knowledge. Learning theorists include developmentalists concerned with the influence of growth on the learning process, behaviorists interested in how experience shapes knowledge construction, and neurophysiologists focused on biological factors in cognitive development. Environment, experience, and biology underlie each learning theory, respectively. Learning has been described as a sensory, psychological, or cognitive experience (Sarasin, 1998). Piaget (1977) saw it as a blend of biological, psychological, and developmental processes. Others maintained that the way individuals learn is influenced by biological, environmental, and cultural factors (Witkin & Goodenough, 1981). That is, learning is a natural process rooted in biology, experience, and individual differences (Smilkstein, 2003).

Learning Theory

Theories of learning abound. For example, Kearsley's (2003) theory into practice database identified theories relevant to particular instructional settings. It summarized 50 major theories of learning and instruction. One can find other listings, such as EmTech's (2005) list of some 30 theories, Funderstanding's (2001) list of 12 different theories on how people learn, and Dunn's (2002) list of nine.

With so many learning theories extant, it seems reasonable to first define learning so some type of order, classification, or categorization is discernable. Dunn (2002) observed that learning was a relatively permanent behavioral change involving both observed activity and internal changes in thinking, attitude, and emotions. He surmised that learning might not be an immediate result of education, or experience, and that motivation was part of learning.

Knowles et al. (1998) determined that "learning theories fall into two major families: *behaviorist/connectionist theories* and *cognitive/gestalt theories"* (p. 22). At the same time, they recognized that "not all theories belong to these two families" (Knowles et al., p. 22). As Merriam (1993) put it, citing the proverb of an elephant described by blindfolded men, "It is doubtful that a phenomenon as complex as adult learning will ever be explained by a single theory, model, or set of principles" (p. 12). Focusing on locus of control for learning, Merriam and Caffarella (1999) identified five key learning theory orientations: behaviorist, cognitivist, humanist, social learning, and constructivist. Learning theories in these five different orientations of learning theory are compared and contrasted in Table 1.

Table 1
Five Orientations to Learning

Aspect	Behaviorist	Cognivitist	Humanist	Social Learning	Constructivist
View of the learning process.	Change in behavior.	Internal mental process.	A personal act to fulfill potential.	Interaction with and observation of others in a social context.	Construction of meaning from experience.
Locus of control/locus of learning.	Stimuli in external environment.	Internal cognitive structuring.	Internal effective and cognitive needs.	Interaction of person, behavior, and environment.	Internal construction of reality by individual.
Associated learning theories.	Behavioral objective. Competency-based education. Skill development and training.	Cognitive development. Intelligence, learning, and memory as a function of age. Learning how to learn.	Andragogy. Self-directed learning.	Socialization. Social roles. Mentoring.	Experential learning. Self-directed learning. Perspective transformation. Reflective practice.

Note. Adapted from *Learning in adulthood: A comprehensive guide* by S. B. Merriam and R. S. Caffarella, 1999. Copyright 1999 by Jossey-Bass, San Francisco.

From examining this table, a reader can see the relationship among the various views espoused by current learning theory. It is clear that there are no definite answers as to which learning theory is "correct."

Workforce Learning

This study involves technical college students pursuing an education in a workforce learning environment. Hence, learning theory as it bears on this aspect of learning is addressed.

Constructivism and instructivism. In viewing the application of learning theory and psychology to technical education, it is perhaps informative to view these applications from two perspectives: constructivism and instructivism. Indeed, the contention between student-centered and teacher-centered approaches has a long history (Emtech, 2005). Constructivism is often related to the philosophies of Dewey and Rousseau, and inspired by Piaget and Vygotsky. On the other hand, instructivism can be viewed as related to faculty psychology, behaviorism, and to the research-based programs of the last few decades known as process-product pedagogy (Emtech).

Herschbach (1998) addressed the concepts of cognitive psychology applied to technical instruction by presenting a constructionist view of instructional design. He concluded that, while cognitive concepts of instructional design are still evolving, “educators concerned with technical instruction in all of its forms need to become versed in cognitive psychology and its instructional design implications” (p. 13). In education, whether in workforce, mathematics, or online, practice guides theory as much as theory guides practice, and practice is guided by methodology.

Methodology. Methodology logically exists within a framework. Rojewski (2002) suggested that a conceptual framework for workforce education consists of three prominent philosophies: essentialism, pragmatism, and pragmatism with a reconstructivist strand. The framework should delineate the mission and current practices of a profession to establish the parameters of that profession (Rojewski). In addition, the framework should ascertain how we got to where we are by accounting for historical events, relating philosophy and practice by establishing the philosophical underpinnings of the field, and providing a format through which actual or needed directions of the field could be understood (Rojewski). Of these, a conceptual framework to “establish the philosophical underpinnings of the field and underscore the relationships between philosophy and practice” (p. 2) is closest to the theory of learning espoused within the field of workforce education.

Essentialism. Rojewski (2002) said, “Essentialism is characterized by an emphasis on basic academics (the 3 R’s), respect for the existing power structure, and nurturing of middle-class values” (p. 10). The essentialist holds that an ideal form is a more perfect form than a natural one; therefore, it is more important to teach ideas and theory than skills for a working life. From its definition, it is clear that essentialism embraces a behaviorist approach to learning.

Pragmatism. On pragmatism, Rojewski (2002) said, "Pragmatic education seeks to prepare students to solve problems caused by change in a logical and rational manner through open-mindedness to alternative solutions and a willingness to experiment" (p. 10). "The desired outcomes for pragmatic education are knowledgeable citizens who are vocationally adaptable and self-sufficient, participate in a democratic society, and view learning and reacting to change as lifelong processes" (p. 10). "Dewey's work is recognized as a significant part of the philosophy known as pragmatism" (Rojewski, p. 10).

John Dewey felt that "interaction as the defining component of the educational process that occurs when the student transforms the inert information passed to them from another, and constructs it into knowledge with personal application and value" (Anderson & Elloumi, 2004, p. 44). Dewey was a defender of project learning and problem solving (Brannan, 2006). Problem-solving learning theory, closely associated with the construction of knowledge, is important in the contemporary technology education curriculum (Cardon, 2000). This theory includes three aspects: cognition, guided practice, and automated behavior (Cardon). Through interaction with problems in technology education curricula, students achieve learning and satisfaction (Cardon, p. 3).

Cardon (2000) supported the idea that hands-on learning theory plays an important role in technology education curriculum and that technology education demands students interact with their learning environment. Hands-on activities are particularly valuable in technology education as interactive tools that bridge the gap between intellectual theory and physical practicality.

Since hands-on activities help learners incorporate new information, they may be described as constructivist techniques.

Gokhale (1996) defined hands-on learning as students learning by doing or experiencing things in the world. Learning is a combination of mental and physical activity. “Dewey (1900) believed that, through hands-on activities, students could combine intellectual stimulation with activities that expanded learning” (Cardon, 2000, p. 4). Hein (1991) explained that this combination of the mental and physical was a manifestation of constructivist learning theory.

Pragmatism with a reconstructivist strand. Rojewski (2002) said the reconstructionist strand of pragmatism “emphasizes the role of career and technical education in contributing solutions to problems such as discrimination in hiring, the glass ceiling experienced by women and members of minority groups, poor working conditions, or the lack of viable job advancement opportunities” (p. 10). It is “explicit in that one of the purposes of vocational education should be to transform places of work into more democratic learning organizations rather than perpetuating existing workplace practices” (p. 10).

The societal issue resolution components, explained as part of the reconstructivist strand of pragmatism, also place the constructivist learner theory in that third philosophical aspect of career and technical education in his model. Since, as Rojewski said, “In the last several decades, pragmatism has been identified as the predominant philosophy of career and technical education” (p. 11), constructivist learning theory is the dominant theory in workforce education. Thus, the primary theory for learning in workforce education can be said to be constructivism.

Mathematics Learning

Assessing how adult technical college students learn mathematics includes consideration of theories and practices of learning and teaching in that area. As with workforce learning, the cognitive area of constructivism is reviewed first in learning and in teaching mathematics.

Constructivism in mathematics learning. Matthews (1998), in his compendium of the constructivist thoughts of Bickhard, Glaserfield, Grandy, Kragh, Nola, Phillips, Slezak, and Suchting on mathematics said, “Constructivism is a major influence in science and mathematics education” (p. 1). However, Matthews (2000) later explained, “there have been some critics of constructivism (Suchting 1992, Phillips 1995, Osborne 1996, Matthews 1998), and some urging caution in its adoption (Millar 1989, Solomon 1993)” (p. 1). Nevertheless, “few would dispute Peter Fensham’s claim that ‘The most conspicuous psychological influence on curriculum thinking in science since 1980 has been the constructivist view of learning’ (Fensham 1992, p. 801)" (Matthew, 2000, p. 1).

Most of the studies in mathematics education support an information-processing view of how learning takes place in traditional mathematic classrooms (Anderson, Reder, & Simon, 2000). Information-processing, like constructivism, is a subset of cognitive psychology (Stahl, 1995). "There is almost universal consensus that only the active learner is a successful learner. Proponents of situated learning and constructivism have proposed a number of modes of instruction that are aimed at encouraging initiative from students and interaction among them” (Anderson et al., p. 20).

Addressing specifically learning mathematics, Dubinsky and McDonald (2001) said, "Mathematical knowledge consists in an individual’s tendency to deal with perceived mathematical problem situations by constructing mental actions, processes, and objects, and organizing them in schemas to make sense of the situations and solve the problems" (p. 4). Thus, for learning mathematics, the constructivist theory is the learning theory principally espoused (Matthews, 2000).

Constructivism in mathematics teaching. Constructivist teaching in mathematics is not well defined (Jaworski, 1994). Some argue that experiential reality must be a part of the methodology of mathematics education. They urge employing the problem-solving and hands-on techniques mentioned for workforce education. Stiff (2007), a past president of the National Council of Teachers of Mathematics (NCTM), said, “A type of social constructivism that applies specifically to mathematics education maintains that mathematics should be taught emphasizing problem solving” (p. 1). Stiff explains, “Interaction should take place (a) between teacher and students and (b) among students themselves; and that students should be encouraged to create their own strategies for solving problem situations” (p. 1).

Integrating new knowledge with existing knowledge to create a deeper understanding of the mathematics is the focus of constructivist philosophies. This places the student as an active participant in the teaching and learning process (Stiff, 2007). Each teacher rightly brings individual and varied techniques to help students deepen existing knowledge of mathematics by assimilating new skills and information. Students are expected to be actively responsible for their own learning. According to Jonassen (1998), the constructivist environment is active, constructive, collaborative, intentional, complex, contextual, conversational, and reflective. The constructivist methodology in mathematics education agrees with this view.

Adults learning mathematics. There is considerable research on how adults learn mathematics. As technical college learners are typically characterized as older, or adult, students, these studies have particular relevance to the teacher of mathematics in technical colleges. For example, consider the 140 dissertations relating to adults learning mathematics cited earlier. Some of these looked at use of technology in supporting traditional methods of teaching mathematics to adults, but the vast majority looked at the differing, or experimental, methods of face-to-face classroom delivery. "Yet the traditional methods we use in the classroom every day have exactly this characteristic--they are highly experimental in that we know very little about their educational efficacy in comparison with alternative methods" (Anderson et al, 2000, p. 20). That is to say, we have yet to discover the "one best way," if such exists, of teaching mathematics to adults in the classroom.

Learning Formats

Online Learning

Theories of online learning. Keegan (1996), in attempting a detailed analysis of the theoretical approaches to distance education, classified them into three groups: theories of independence and autonomy, theories of industrialization of teaching, and theories of interaction and communications.

In addressing theories of independence and autonomy, Gibbons and Wentworth (2001) said, "The nature of the online learner suggests that online instructor training be based on andragogical theory" (p. 2). They asserted, "Andragogy describes the approach based on self-directed learning theory" (p.1).

Jonassen (1996) espoused the practical approach in theories of industrialization of teaching. He said learning tasks should include "those that have real-world relevance and utility, that integrate those tasks across the curriculum, that provide appropriate levels of complexity, and that allow students to select appropriate levels of difficulty or involvement" (Jonassen, p. 271).

In the area of theories of interaction and communications, the American Distance Education Consortium (ADEC) (2003) identifies group collaboration and cooperative learning as an important characteristic of quality Web-based teaching and learning. “Constructivism favors collaborative work groups that actually work together interactively to accomplish shared goals rather than just talk about what each group member will do individually at a later time” (Alesandrini, 2002).

Growth of online learning. These theories are important because the use of online classes has rapidly expanded over the last four years (Allen & Seaman, 2004). “Over 1.6 million students took at least one online course during Fall 2002” (Allen & Seaman, 2003, p. 1). From 2003 to 2005, the number of students taking at least one online class was projected to climb from 1.9 million students to 2.6 million students (Allen & Seaman, 2004).

For technical colleges in Georgia online classes are managed by the Georgia Virtual Technical College (GVTC). In 2004, the GVTC served more than 32,287 online students (Georgia Department of Technical and Adult Education (DTAE), 2005a). This increased in 2005 by 15% to 37,112 (DTAE, 2005b). Courses offered online increased by 18%. This level of increase is particularly true in mathematics courses in the technical college. For example, in 2003 an associate degree level contemporary mathematics course for Georgia technical college students in several fields was not available online. In 2005, almost 100 mathematics classes were offered online (GVTC, 2005). By spring 2008, 111 mathematics classes were offered online, including classes for all of the associate level mathematics courses (GVTC, 2008).

With so many of the mathematics courses intended to support a technology education for the Georgia technical college students being offered online, and with numeracy such an important aspect of technology (Steen, 2001), success in these online mathematics courses is critical. Since every diploma or degree offered in the TCSG includes a mathematics class (DTAE, 2008), if a student cannot pass their mathematics class, he or she may not be able to complete a diploma or degree.

Problems in online learning. Educational Internet use is “widespread and rapidly growing” (Dutton et al., 2002, p. 1). Thousands of university courses have been developed for delivery entirely via the Web. Colleges and universities urge faculty to create more and more online versions of their courses, thus accelerating this trend” (Dutton et al., p. 1). Clearly, diligent application of learning theory to this course development is called for. However, Som and Ott (2004) found that while conversion of traditional courses to online classes did increase, the “faculty at the university level still lacked the experience and skills in dealing with online course development" (p. 1). This had been identified earlier by Lewis, Snow, Farris, and Levin, D. in their 1999 National Center for Education Statistics report (1999a) and subsequent issue brief (1999b) on distance education in higher education institutions.

According to Zemsky and Massey (2004), "One of the more hopeful assumptions guiding the push for e-learning was the belief that the use of electronic technologies would force a change in how university students are taught” (p. 52). Unfortunately, “only bureaucratic processes have proven to be more immutable to fundamental change than the basic production function of higher education” (Zemsky & Massey, p. 52). In fact, Zemsky and Massey found that “most faculty today teach as they were taught - that is, they stand in the front of a classroom providing lectures intended to supply the basic knowledge students need" (p. 52). If what we are doing is exporting the face-to-face classroom to an asynchronous online delivery system, we need to be certain we continue to provide the needed education for our students. Part of the challenge in providing that needed education can be found, perhaps, in the translation of the curricula from one medium to another medium.

Simmons, Jones, and Silver (2004) identified these challenging aspects of converting the characteristics of the traditional classroom to online class realities, and they provided the following steps to make this transition: envision the course online, understand the process of converting the content to online content, plan the transition, and develop the online content. Som and Ott (2004) also urged a systematic planning approach by educators in designing online classes in order to have a positive influence on course development. They believed the educator's "ability to deliver the same quality of education as the traditional class format could influence future expectations regarding [the] online form of delivery" (p. 1). Simonson, Smaldino, Albright, and Zvacek (2006) identified the expertise of the instructors making the conversion as critical in transferring and transforming traditional class activities to an online environment without affecting students' concentration, motivation, thought, mastery, and comprehension.

Zemsky and Massey (2004) painted a more pedantic picture when they reported that, for the most part, faculty who made e-learning a part of their teaching did so by having the electronics simplify tasks, not by fundamentally changing how the subject was taught. Nearly all faculty use email to communicate with their students, and many post assignments on web pages or use computerized test generators; but most do not give assignments based on publisher's Websites or interactive CD-ROMs that often accompany textbooks. Few use available tools, such as PowerPoint, Blackboard, and WebCT, effectively. Even the technology-savvy often fail to make assignments fresh or obviously fitted to the new media. Gold (2001) explained that instructors are creatures of habit and, without training, will attempt to transfer successful classroom strategies to online media. Finally, Zemsky and Massey said, "For the most part, however, what the Web provides are merely correspondence courses distributed electronically" (p. 5). Thus, the biggest criticism online classes seem to face is that they only provide an alternative delivery system for a product designed for the delivery system of the traditional classroom.

Zemsky and Massey characterized what had been foreseen in online learning in the following passage:

> Learning would be customized, self-paced, and problem-based. Course instructors would be replaced by designers and facilitators - the "sage on the stage" would become the "guide on the side." Students would have the ability to model outcomes, conduct experiments based on well-documented laboratory simulations, rapidly exchange ideas with both fellow students and teaching faculty, and, where appropriate, join global learning communities not unlike the contract bridge communities that have made tournament bridge on the Internet an exercise in international competition. (p. 2)

While Zemsky and Massey (2004) anticipated that "the marriage of new electronic technologies and newly accepted theories of learning promised to yield a revolution in pedagogy itself" (p. 1), what they found was merely a change in the media used to deliver the same timeworn content. Carnevale (2004) also assessed that "the boom in educational technology has not lived up to its promise" (p. 1).

Zemsky and Massey (2004) explained that, even with our high technology-based economic environment in this country, and "despite massive investments in both hardware and software, there has yet to emerge a viable market for e-learning products" (p. iii) with a dominant design for learning objects and "a technological focus on what students really want" (p.59).

They concluded, “We require ways to motivate students to learn using the technologies and to bring human interaction into the equation in optimal ways” (p. 59).

Comparing Online and Face-to-Face Learning

Do differences exist in successful and unsuccessful online mathematics students and successful and unsuccessful face-to-face mathematics students? Addressing the similarities and differences of online and face-to-face classes is important to understanding the context of this study. Zemsky and Massey (2004) found the most successful online courses are “courses that teach a particular subject; courses that are part of a degree program most often at the graduate or professional level; and, finally, courses that offer certification in a vocational or technical skill" (p. 5). The fact that courses offering certification in a vocational or technical skill are among those found most successful is encouraging for the technical colleges in Georgia, with up to 50,000 students served by online classes in these vocational and technical areas. All of these skills require a basic mathematics component. As has been noted, in the TCSG, learning this mathematics can be done online or face-to-face.

Differences in online and face-to-face classes. Differences in these two formats exist in two realms, the characteristics of class participants and the media for class presentation. Gold (2001) said that the “divergence between what works in the traditional classroom within a stable cohort of learners communicating synchronously face-to-face is qualitatively different from [what works in] an online asynchronous one” (p. 36).

Dutton et al. (2002) found that online students differ from lecture students in a number of observable characteristics. “The online class had a larger number of older students, students who were not full-time or enrolled in a regular undergraduate degree program, students with greater work and/or childcare responsibilities, and students who had more programming experience”

(Dutton et al., p. 10). Addressing the class participants in online and face-to-face learning, Destefano and Grosshandler (2003) said "significant differences in learning styles were found in information processing habits” (p.1). Online students used reflective observation and abstract conceptualizations, while face-to-face students engaged in experimentation that is more active. Specifically in the area of mathematics, one study found traditional mathematics classrooms as not suited to a learning style characterized as connected knowers (Keast, 2006).

Turning to media, Joy and Garcia (2000) said that "although there are many media comparisons in the literature, the most common approach has been to compare traditional (teacher-mediated) learning with technology-based devices as either a substitute for or supplement to the teacher” (p. 1). The focus on specific attributes of media has grown with improvements in technology. In recent years, comparisons have shifted emphasis from television and programmed instruction to personal computers and distance education (Joy & Garcia).

In reviewing the differences between online and face-to-face class formats we should note that “when online learning was first conceived and implemented, a majority of educators believed that it could never be as good as face-to-face learning” (Swan, 2003, p. 1). The experiences with computer-based instruction (CBI) and computer aided (or assisted) instruction (CAI) may give some insight into the cause for this negative view. “CAL (computer aided / assisted learning), CBL (computer based learning), CBI (computer based instruction), [and] CAI (computer aided / assisted instruction) are among the many acronyms used to describe various forms of computer mediated teaching tools” (Sangster, 1999). Sangster found that, unless a course component offered via media facilitation was very well planned and integrated, only diligent students willing to devote significant time and attention to their studies will benefit.

However, when the learning environment was structured to include well-planned and integrated media packages, increased and accelerated learning would take place across the student population.

From the review of research for technology-based courses in general, Joy and Garcia (2000) cautioned, "Much of the literature purports to have found no significant difference in learning effectiveness between technology-based and conventional delivery media. This research, though, is largely flawed" (p. 1). Joy and Garcia gave the following example: “Maddux observed a shift toward improvement in the internal design of computer delivery in experimental comparison studies, which he attributed to better-controlled laboratory research” (p. 34). Joy and Garcia concluded, "The major flaw in much of the research was its limited generalizability beyond the laboratory" (p. 2).

Assessments by Joy and Garcia (2000) of previous studies of instruction using these computer mediated teaching tools were not encouraging. In fact, even when they did tend to support use of computer-mediated instruction, the methodology of the studies was called into question. Joy and Garcia reported that, in research of computer-mediated instruction, "there were significant differences in favor of CBI in only two of fifteen studies that controlled for instructional method" (p. 4). They further reported that many studies that showed favorable results for computer-mediated instruction had design flaws in group sizes, time periods of assessment, and assessment of abilities of control groups. Joy and Garcia concluded, “Differences favoring CAI over non-CAI delivery, for adult education programs are unrealistic” (2000, p. 4). Joy and Garcia, also cited flawed methods used in determining that computer mediated instruction provided statistically significant effective differences in mathematics learning from traditional instruction.

Specifically addressing mathematics, Joy and Garcia (2000) found that a study of CAI effects on mathematics achievement was flawed because it failed to implement proper controls. Therefore, the data could not be verified and the significant differences claimed may or may not exist. For example, Funkhouser (1993) investigated problem-solving software and its influence on student attitudes about mathematics. However, Joy and Garcia found Funkhouser's study, that indicated using problem-solving software improved student attitudes towards mathematics, was flawed. While he used pre- and post-tests to measure knowledge and attitude, he used the same assessment tool for both. Additionally, he had no control group, nor did he control for random selection.

Joy and Garcia (2000) said that, on the one hand, without careful control for the most likely factors explaining variance in student achievement, finding significant difference between experimental and control groups is less likely because "there is no absolute difference affecting only the treatment group" (p. 6). On the other hand, "if a significant difference is found in poorly designed research, it may be the result of one or more uncontrolled variables, such as a specific method of instruction that was presented to the experimental group only" (Joy & Garcia, p. 6).

Similarity in online and face-to-face classes. Nevertheless, numerous studies have concluded that online classes have equivalent outcomes to traditional classroom based face-to-face classes (Swan, 2003). These studies found no significant difference between the two treatments. However, we must ask if we are not seeing what Clark (1983) found earlier with CBI research: "no significant difference results simply suggest that the changes in outcome scores (e.g., learning) did not result from any systematic differences in the treatments compared" (p. 447).

Many researchers have found that not to be the case. Kassop (2003), on the question of academic quality and rigor, achievement of learning objectives, and depth and breadth of student learning being equivalent when comparing online and face-to-face, said “Not only is the answer to these questions a resounding ‘yes,’ but there are many ways that online courses may actually surpass traditional face-to-face classes in quality and rigor" (p. 1). According to Dutton et al. (2002), studies “of online and traditional lecture formats indicate that, on average, students perform at least as well in classes with an online component. Moreover, there is evidence that student ratings of various aspects of courses are also similar for online and lecture modes” (p. 2).

Flood, Lockhart, and Thomas (2003) found no significant difference in outcomes in studies in England. Johnson, Aragon, Shaik, and Plama-Rivas (2000) found no significant differences in outcome between the two groups they studied at a Midwestern university. However, they said, “It is interesting to note that, while there was a significant difference between the online and face-to-face students in terms of cognitive control functions, it seemed to have little impact on course performance” (Johnson et al., p. 13).

Swan (2003) reported on numerous studies comparing online and face-to-face classes that found similar results from a learning outcome perspective:

> Maki, Maki, Patterson and Whittaker (2000), in a two-year quasi-experimental study of undergraduate students, found more learning as measured by content questions and better performance on examinations among students in the online sections of an introductory psychology course. Fallah and Ubell (2000) compared midterm exam scores between online and traditional students at Stevens Institute of Technology, and found little or no difference in student outcomes. Freeman and Capper (1999) found no differences in learning outcomes between business students participating in role simulations either face-

> to-face or asynchronously over distance. Similarly, Ben Arbaugh (2000) compared the course grades of classroom-based and Internet-based MBA students and found no significant differences between them. In a study of community health nursing students, Blackley and Curran-Smith (1998) not only found that distant students were able to meet their course objectives as well as resident students, but that the distant students performed equivalently in the field. Similarly, Nesler and Lettus (1995) report higher ratings on clinical competence among nurses graduating from an online program than nurses who were traditionally prepared. (pp. 1-2)

From a faculty viewpoint, Swan (2003) explained, "Several researchers have used faculty perceptions of student learning as a measure of learning effectiveness in online courses" (Swan, p. 2). "Dobrin (1999) … found that 85% of the faculty teaching online courses felt that student learning outcomes were comparable to or better than those found in face-to-face classrooms. Hoffman (1999) reported similar findings, as did Hiltz (1997)" (Swan, p. 2).

From a student viewpoint, Swan (2003) said, "Researchers have surveyed students and used their perceptions of their own learning as an effectiveness measure" (p. 2). Of 1,400 students enrolled in SUNY Learning Network's online classes, forty-one percent believed that they learned as much as they learned in traditional classes, and forty-seven percent thought they learned more (Swan, Shea, Fredericksen, Pickett, Pelz, & Maher 2000). "Many researchers (Fulford, 1993; Picciano, 1998; and Dziuban, 2001) have reported similar findings" (Swan, p. 2).

Swan (2003) further refers to a "No Significant Difference" website maintained by Thomas L. Russell that presented the results of hundreds of "research reports, summaries, and papers reporting no significant differences between the learning outcomes of students learning over distance and students learning in traditional classrooms" (p. 2). In addition, Swan reported on a review of distance education studies involving students in the military, in which no significant learning differences between resident and distant groups in any of the research were found. Swan also reported on nineteen empirical studies comparing the learning effectiveness of asynchronous online courses with that of equivalent face-to-face courses. "Using objective measures of content learning as well as survey responses by faculty and students, the studies provide overwhelming evidence that ALN tends to be as effective [as] or more effective than traditional course delivery" (Swan, p. 2).

What is the consensus? Are these results unanimous for all studies? The answer is "no." Swan (2003) identified a study that "compared traditional, correspondence, and online learners and found that achievement test scores were highest for correspondence students and lowest for students taking courses online" (p. 2). In addition, Swan cited "significantly worse performance on examinations for virtual graduate microeconomics classes," but said, "These sorts of findings, however, are very much in the minority" (p. 2).

We are also reminded that, in comparing media, improvement in learning may come from the instructional *design*, not the medium that delivers the instruction (Clark, 1994). Clark said, "When people research media effects, they find either no effect (because they are comparing different media but the same method); or an effect, but only because they are comparing different media and different methods" (p. 1). In fact, there has been a debate in the instructional design literature about whether there are any unique attributes of *any* media that can promote improved learning, with Clark (1983, 1994) suggesting "no," and Kozma (1991, 1994a, 1994b) suggesting "yes." Kozma's main argument has been that media and methods are inextricably interconnected. However, regardless of the methodological problems, Swan (2003) said, "It is clear that when compared using gross measures of learning effectiveness, students learn as much if not more from online courses as they do in traditional higher education courses" (p. 2).

In short, "as with any instructional mode, the quality of online courses varies, but the potential - often met and still expanding - is on a par and in some respects even better than with the traditional face-to-face mode" (Joy & Garcia, 2000, p. 5). Joy and Garcia said, "The important point, however, is that online education can be done well, and the demand for it is such that we all have to work to make it better. It is here to stay for all of the right reasons." (p. 5).

As cited above, studies have found online classes to be equivalent to face-to-face classes in outcome measures of grade and general student performance. The usual conclusion has been that there are no significant differences in outcomes for online and face-to-face classes, regardless of the classes compared. Specific comparisons of online and face-to-face classes in mathematics have come to the same conclusion (Mascuilli, 2000). Thus, it would appear that since online courses, including mathematics courses, are here to stay, we should determine how to do them well.

Application of Research in Online and Face-to-face

To design and deliver an online class well, it seems desirable that we know the characteristics of online learners so we can design to these characteristics. If there are differences in the characteristics of the students in online and face-to-face classes, are there differences in the way students in the classes learn? Swan (2003) said, "The epistemological problem with the 'no significant difference' concept, then, is that it glosses over real differences in the asynchronous online medium that might be uniquely supportive of particular ways of knowing and learning" (p. 3). Swan said, "The biggest obstacle to innovation in online learning is thinking things can or should be done in traditional ways. Trying to make online education 'as good' as traditional education often encourages us to make it the same as traditional education" (p. 3). The effort to obtain equivalency by equivalent methods may ignore the "potential to support significant paradigm changes in teaching and learning" (Swan, p. 2).

According to Joy and Garcia (2000), use of technology delivery systems does not necessarily result in better learning by students. Regardless of the medium chosen, they suggested adhering to time-tested instructional design strategies. Since learning effectiveness is a function of effective pedagogical practices, "the question for ALN practitioners ought to be: What combination of instructional strategies and delivery media will best produce the desired learning outcome for the intended audience?" (p. 1).

We should view the technology that permits online courses as a tool and not the purveyor of online education. Choosing relevant strategies, techniques, and new possibilities plus adjusting traditional skills, are important factors for the success of distance instruction in any class, including mathematics (Som & Ott, 2004). Important aspects of these relevancies are, indeed, the students who chose to take online classes and the students who chose to take face-to-face classes.

As stated above, accepted best practices for on-line education should be used in class design. This implies that the quality of mathematics classes or the ability of mathematics classes to deliver the desired results is directly related to the design of the class. Assuming best practices are used in class design, the determining factor for success in the online class is the student. If the design of the class fits the characteristics of the learner, then the class would seem to be designed properly. Perhaps of most importance for the designer and provider of both online and face-to-face classes is how the characteristics of successful and unsuccessful students in each medium differ.

Learning Readiness

Readiness for learning is important to the individual student and the educational organization alike. The readiness for education at a distance indicator (READI) was used in this study to collect data about learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency of individual students taking a basic mathematics course in technical college. Results from two studies indicated that READI is a reliable indicator of a learner's level of readiness for studying online. Atanda Research conducted a study in 2007 concerning the relationship of READI scores and measures of academic success and goodness of fit of distance education as a measure of construct validity (Atanda, 2007). The study was replicated in 2008 as a part of a learner's dissertation research that involved 2,622 students who had taken READI representing over 300 schools (Decade Consulting, 2009a). Also in 2008, Applied Measurement Associates of Tuscaloosa, Alabama conducted reliability coefficient calculations for the questions in READI. The Atanda studies showed that READI is an indicator of the goodness of fit for distance learning as is evidenced by multiple correlations that are statistically significant at the .01 level. Applied Measurement found high reliability for three of the areas measured (Decade Consulting, 2008).

The Student

Even if instructors follow best practices in designing their classes, there is still the element of the student himself or herself. "The learner brings a set of skills, experiences, and expectations to the learning environment" (Hughes, 2004, p. 369). In viewing their demographics we find that distance education students are older, more likely to be married, more likely to be female in undergraduate courses, more likely to work full-time, more likely to be part-time students, and more likely to have higher average incomes than their face-to-face counterparts (Ashby, 2002). Most distance education students are enrolled in public institutions whose most common delivery method for distance education is the Internet (Ashby). Most students are in classes related to business, humanities, and education (Ashby).

Identifying Readiness

Readiness to succeed in an online class is a combination of many factors. Several specific factors that were most important from the viewpoint of the READI instrument, used to assess a student's readiness for an online class, were identified above. There are other tools, similar to READI, used for the same reason. SORT [Student Online Readiness Tool] is used by the University System of Georgia, under governance by the Board of Regents, in conjunction with its eCore online classes (Board of Regents of the University System of Georgia, 2003). However, GVTC and the TCSG have sanctioned READI by its adoption and use.

Indeed, because the technical colleges in Georgia are offering more and more classes each year over the Internet through the Georgia Virtual Technical College that serves more and more students each quarter (GVTC, 2009b) the READI tool may be considered a necessity. The online asynchronous learning format for course delivery does make attending classes for the student more convenient than attending face-to-face classes. Of course, Georgia technical colleges continue to deliver equivalent face-to-face classes on the same subjects. Students now make their own choices as to which delivery system they want to use to gain the mathematics knowledge and skills they need for their technology curriculum. However, can they be assured that they will learn mathematics just as well in face-to-face as in online classes? The READI is one tool provided to help them decide. The following theories are the basis for elements of the READI evaluation.

Learning Styles. In the area of learning styles, Witkin and Goodenough (1981) suggested, “People have preferred ways of integrating the diverse sources of information available to them” (p. 7). This emphasizes the fact that individuals perceive and process information in very different ways (Wishart, 2004). Sarasin (1998) called these styles of learning "the preference or predisposition of an individual to perceive and process information in a particular way or combination of ways" (p. 3). Felder (2005) said learning styles were “characteristic cognitive, affective, and psychological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment” (p. 58).

The three different applications for which educators use learning styles focus on the individual, curriculum development, and diagnostic-prescriptive (Reed, 2000). Various theories address learning styles; however, “Regardless of a theory's particular focus, [there are] . . . remarkable similarities between dominant theories” (Reed, p. 40).

Learning styles theory states that people approach learning and studying differently (Gilbert & Han, 1999). “Learning styles theory is based on research demonstrating that, as the result of heredity, upbringing, and current environmental demands, different individuals have a tendency to both perceive and process information differently” (Riedl, 2002, p. 10).

Multiple Intelligences. The second theory, the theory of multiple intelligences, was first developed by Dr. Gardner in 1983 (Armstrong, 2000). Central to Gardner’s theory is that intelligence may manifest itself in multiple areas. Gardner (1983) initially identified seven areas of intelligence: linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal and intrapersonal. Later, he added a possible eighth intelligence, naturalistic intelligence (Gardner, 1999). In addition, he recognized the possibility of even more intelligences (Gardner, 2003).

As identified above, computer information systems competency, on-screen reading ability, and keyboarding proficiency of individual students are measured by READI. The existence of multiple intelligences suggests that measures of different characteristics of people can lead to insights into reasons for their particular levels of performance (Hearne & Stone, 1995; Green, Hill, Friday, & Friday, 2005). A detailed explanation of each of the seven intelligences originally identified by Gardner is contained in Appendix A.

Correspondence between Multiple Intelligences and Learning Style. Memletics, a learning company, provides a self-administered individual assessment of seven learning styles (Advanogy.com, 2007a). Sajac (2009) identifies these seven learning styles as corresponding to the seven independent means of information processing or intelligence types initially posited by Howard Gardner in his theory of multiple intelligences. Decade Consulting (2007c), as part of their Readiness for Education at a Distance Indicator assessment for individuals, identifies an individual's preferred learning styles using an adaptation of the learning styles instrument used by Memletics. While viewing the correspondence between multiple intelligences and learning styles, it should be noted that, as Lane (2000) cautioned, "It is tempting to equate learning styles and intelligences because there are similarities, but until we have a much better understanding of both, it is best to avoid mixing the models" (p. 3). Gardner (2006) asserted that the intelligences identified by his theory are not specifically styles of learning. Nevertheless, others have identified a natural correspondence behind these intelligences and learning styles For example, according to Green (2001), Sternberg (1994) and Jensen (1998) viewed Gardner's multiple intelligences theory identify his theory as "subcomponents of intelligence, as an explanation for individual learning styles/talents or practical intelligence, or as not even a theory at all" p. 23-24. Chapman (2007) provided a list of capabilities and perceptions that correspond with the intelligence types and learning styles. Table 2 shows these correspondences.

Table 2
Correspondence Between Learning Style, Intelligence Type, and Capability and Perception

Learning style	Intelligence type	Capability and perception
Verbal	Linguistic	words and language
Logical	Logical-Mathematical	logic and numbers
Aural	Musical	music, sound, rhythm
Physical	Bodily-Kinesthetic	body movement control
Visual	Spatial-Visual	images and space
Social	Interpersonal	other people's feelings
Solitary	Intrapersonal	self-awareness

Note. Adapted from "Howard Gardner's Multiple Intelligences," by A. Chapman, 2007, http://www.businessballs.com/howardgardnermultipleintelligences.htm

Causal-Comparative Research

We are concerned about delivering mathematics classes that fit the method by which adult technical college students learn the mathematics required by their programs. It is clearly important for us to learn more about those students who are successful at learning mathematics, to the degree that they earn a passing grade, and those that are not in both online and face-to-face classes.

Comparing these groups to learn the degree of differences among them in preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency will aid in class design. Quantitative research, aimed at ascertaining if differences exist, is a valuable step in this direction The characteristics of causal-comparative design allow this comparison, recognizing that total control cannot be exercised over all the factors involved in this study.

In performing quantitative research, it is important to ascertain what form that investigation will take. Correlational and causal relationships are two types of relationships investigated in research (Bordens & Abbott, 1988). "A correlational relationship is one in which the values of variables are linked in some way" (Bordens & Abbott, p. 58). The values are said to covary (Bordens & Abbott). One may or may not cause the other. "The mere fact of a strong correlation does not prove anything about the nature of cause and effect" (Hurlburt, 2003, p. 409). In establishing causation, "demonstrating that two variables are correlated is important because a correlation must exist if a causal link exists between them" (Bordens & Abbott, p. 59). For Fraenkel and Wallen (2006), another similarity was that, should relationships be identified, experimental research is often used to study these relationships later.

Bordens and Abbott (1988) defined a causal relationship as "one in which changes in one variable cause changes in another. When you show that changes in the value of your dependent variable are caused by changes in your independent variable, you have established a causal relationship" (p. 58). Hurlburt (2003) cautioned, "It is frequently tempting to conclude that if a correlation coefficient is large, then one of the variables causes the other" (p. 409).

Perhaps the best way to establish causation would be through experimental research. Experimental research is an attempt by a researcher to maintain control over all factors that may affect the result of an experiment. One method to do this is to "conduct a rigorously controlled experiment in which all the variables except the one of concern are held fixed" (Freund, 1992, p. 557), thus eliminating causation by extraneous factors. Another method is through randomization wherein "we design or plan the experiments in such a way that the variations caused by extraneous factors can all be combined under the general heading of 'chance'" (Freund, p. 557). This is described as a completely randomized design. In particular, randomized design is research in which at least one independent variable is manipulated, other relevant variables are controlled, and the effect on one of more dependent variables is observed

(Fraenkel & Wallen, 2006). In practice, researchers "often try to control some of the factors and randomize the others, thus planning experiments that are somewhere between the two, [as in analysis of variance]" (Freund, p. 558).

Since strictly experimental research is not possible in this study because control is not exercised over the treatment variables, strict causation of significant differences, if any, cannot be established. When the experimenter does not have control over the treatment variable, studies that Hurlburt (2003) called quasi-experiments, *in situ* studies, or passive-observational studies must be used. One such is the causal-comparative design, which is the design that has been chosen for this study. Both causal-comparative and correlational studies search for relationships among variables (Fraenkel & Wallen, 2006).

There is an important distinction between true experiments and other studies in which the experimenter does not have total control over the treatment variable (Hurlburt, 2003). The experimenter controls the treatment variable in a true experiment and assigns a level of that variable to each subject randomly. "This randomness guarantees that the treatment variable will be assigned to each subject entirely independent of any naturally occurring characteristics of that subject, which is why the treatment variable is called the 'independent' variable" (Hurlburt, p. 241).

As it relates to research design, Hurlburt drew a distinction between true experiments and other studies because "the ability to randomly manipulate the independent variable provides the strongest possible evidence for inferring that the different levels of the independent variable actually cause different values of the dependent variable" (p. 241). However, Hurlburt went on to say, "Even though the inferences about causality that can be drawn from the two kinds of experiments are quite different, the statistical analyses of true experiments and the other studies are identical" (p. 241).

Causal-comparative and experimental research are similar in several ways. Both seek to determine relationships among variables in the data (Johnson, 2000). In addition, both types of research usually have at least one categorical variable and both compare group performances to determine relationships (Frankel & Wallen, 2006). Both investigate dependent and independent variables; however, unlike experimental research in which the independent variable is controlled by the experimenter, there is no control of the independent variable in causal-comparative research. That is, the researcher does not attempt to influence individuals being studied in a causal-comparative design (Frankel & Wallen, Johnson). Another difference is that researchers sometimes assign subjects to treatment groups in experimental research, whereas in causal-comparative research, the groups are already formed (Frankel & Wallen).

Frankel and Wallen (2006) noted that causal-comparative research is sometimes confused with correlational research. One similarity in both types of research is that they do not include manipulative control of variables by the researcher. While both attempt to identify variables for possible further study through empirical research, correlational studies investigate two or more quantitative variables. Causal-comparative studies, in comparison, focus on at least one categorical variable. Another difference is that correlational research requires a score on each variable for each subject, while causal-comparative research compares two or more groups of individuals (Frankel & Wallen, 2006; Johnson, 2000).

"Causal-comparative educational research attempts to identify a causative relationship between an independent variable and a dependent variable. However, this relationship is more suggestive than proven, as the researcher does not have complete control over the independent variable" (Wasson, 2003, p.1). For example, while the group membership variable is manipulated in experimental research to create differences, group differences already exist in causal-comparative research (Fraenkel & Wallen, 2006). "If the researcher had control over the independent variable, then the research would be classified as true experimental research" (Wasson, p. 1). The purpose of causal-comparative research is to find relationships when total control is not exercised over all factors.

Wallen and Fraenkel (2000) identified three types of causal-comparative research. Their type 1 was the exploration of effects on the dependent variable caused by membership in a given group. Type 2 was the exploration of causes by the independent variable of group membership. Their type 3 was the exploration of the consequences of an intervention. Fraenkel and Wallen (2006) suggested that in investigating a problem using causal-comparative research, the first step is to identify and define the particular phenomenon of interest. One form of the statement or title of a causal-comparative research could be "The effect of [independent variable] on [dependent variable] for [subjects], with the understanding that the independent variable is not under experimental control" (Wasson, 2003, p. 1). This is followed by evaluating possible causes for the phenomenon or consequences of the phenomenon under investigation. Fraenkel and Wallen also advised that, in sample selection for the study, it is important to define carefully the characteristics to be studied before selecting groups that differ in this characteristic.

Summary

This chapter reviewed the foundational theories of learning and learning as it applies to workforce education, mathematics, and the online learning environment. It also reviewed the research concerning online and face-to-face learning formats and reviewed the application of that research to online class design. It next addressed the aspect of readiness for online education and the aspects of that readiness. Finally, it addressed the causal-comparative methodology for research that is used in this study.

CHAPTER 3

METHOD

Introduction

This chapter identifies the method used in conducting this research to determine differences in the characteristics of technical college students in online and face-to-face basic mathematics classes in an effort to find indicators for success or lack of success in the class. It presents the purpose of the research, the design of the study, sample selection, data collection instruments, data collection procedures, and data analysis. The section describing the study design includes a discussion of validity and reliability issues.

Research Purpose

The purpose of this study was to examine the differences in preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency of technical college mathematics students in online and face-to-face versions of a basic mathematics course (MAT 1012 Foundations of Mathematics). These students comprised face-to-face class students who were successful, face-to-face class students who were unsuccessful, online class students who were successful, and online class students who were unsuccessful in the selected course.

In the context of this study, an online class was one where all instruction and assigned work was managed using the Internet. A face-to-face class was one in which students reported to a physical classroom for traditional instruction that could include Web-enhanced or hybrid Internet components. Each student was categorized as either succeeding in his or her class or not. A grade of

C or better in a class at a technical college would be a 70% average grade or higher (TCSG, 2008a). This grade is required for the TCSG to consider this class transferable within its system (TCSG). Students were considered successful when they achieved a grade of C (70%) or better. The inventory instrument called Readiness for Education at a Distance Indicator (READI) was used to obtain a numerical assessment of the preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency of each student in the study (Decade Consulting, 2009c).

The four questions guiding this research were based on four areas evaluated by the Readiness for Education at a Distance Indicator (READI) survey instrument.

1. Are there statistically significant differences in the preferred learning styles of successful and unsuccessful face-to-face and online students in a basic mathematics course?

2. Is there a statistically significant difference in the computer information system competency of successful and unsuccessful face-to-face and online students in a basic mathematics course?

3. Is there a statistically significant difference in the on-screen reading ability of successful and unsuccessful face-to-face and online students in a basic mathematics course?

4. Is there a statistically significant difference in the keyboarding proficiency of successful and unsuccessful face-to-face and online students in a basic mathematics course?

Design

A causal-comparative design was used for this study. Causal-comparative research attempts to determine the cause-and-effect relationships that already exist between groups of people. It is non-experimental in nature, and requires comparing previously established conditions among the groups being studied (Fraenkel & Wallen, 2006; Johnson, 2000). The groups in this study, based on two class formats, had two levels of student success for each. Identification of the class format of group members occurred at the beginning of the class, while measures of success were determined at the completion of each class when the students' grades were assigned. This study focused on whether preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency differed significantly between face-to-face and online students, both successful and unsuccessful. Since students self-selected the course they would take, control was not exercised over the selection of the initial group members, nor was control exercised over whether or not a student passed the class.

Quantitative investigation generally involves the application of statistical methods to ascertain relationship among variables, dependent and independent (Freund, 1992). Various procedures are used in statistics to compare data collected in research depending on the nature of the study. As this study compared the two groups, each with two levels, for the characteristics identified, a two-way analysis of variance (ANOVA) was identified as the best method to accomplish the objectives of the study (Hurlburt, 2003). A dependent variable is defined as "the measured outcome of interest" (Hurlburt, p. 579). The measured characteristics of preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency for each student comprised the dependent variables in this study. An independent or treatment variable is one whose value defines group membership (Hurlburt). The groups, defined by student class selection and success or lack of success in the course, comprised the independent variables. Because changes in the independent variables have already occurred and researchers must study them after the fact to determine their effects on the dependent variables, causal-comparative research is also referred to as *ex post facto* research. As this study did not influence which students selected which method of learning mathematics, the treatment condition was only identified – not randomly assigned.

Weaknesses of causal-comparative research include lack of randomization and the inability to say definitively whether a particular factor was the cause or the result of observed behaviors (Frankel & Wallen, 2006). The evidence provided by causal-comparative research designs is weaker than that provided by experimental research designs; hence, determining causal patterns with any degree of certainty is difficult. Inability to manipulate an independent variable, as well as threats to internal validity, is also a disadvantage to causal-comparative research. Results of causal-comparative research must be interpreted with caution because, even though a relationship may be identified, the nature of causal patterns cannot be fully established.

This study used quantitative methods for data collection and analysis. Both validity and reliability of this study depended on the appropriateness of these methods and their proper application. Research credibility is commonly indicated by its internal validity, external validity, and the reliability of its findings.

Internal Validity

Internal validity is the degree to which observed differences in the dependent variable are directly related to the independent variable, not to some other uncontrollable variable (Fraenkel & Wallen, 2006). Fraenkel and Wallen characterized the lack of randomness and inability to manipulate an independent variable in causal-comparative studies as threats to internal validity. A threat to internal validity resulting from a lack of randomness is subject selection bias. The fact that students in this study self-selected the online or the face-to-face class raised the threat to internal validity. It is possible that the personal characteristics of the students themselves accounted for some observed relationships (Fraenkel & Wallen).

Additional threats to internal validity were location, instrumentation, and loss of subjects (Fraenkel & Wallen, 2006). Studies involving exploration of the consequences of an intervention are open to implementation, history, maturation, attitude of subjects, regression, and testing threats (Fraenkel & Wallen). A final internal validity threat was that of researcher bias. A cause of this is influence by the researcher on the subjects of the research. A common method for controlling this is preventing contact between the researcher and the subjects (Fraenkel & Wallen).

Location bias was minimized by use of multiple campuses with differing local populations from which to draw their students. The use of READI, an accepted evaluation instrument, lessened instrumentation bias. In addition, all mathematics classes used in this study followed a common competency standard and grading scheme. The loss of subjects threat was minimized by incorporating these losses in the design. Subjects who were lost were *de facto* not successful in the mathematics course they were taking. Intervention bias was negligible in that the only intervention was the students' completion of the READI instrument, which all students taking this courses were required by the course syllabus to complete. Finally, researcher bias was reduced by having the only area of direct researcher intervention, the classroom, balanced by using multiple classes with different instructors and a common standard and grading scheme for all classes.

External Validity

External validity refers to whether or not findings can be generalized to other situations and populations beyond the subjects of the study (Dimitrov & Runril, 2003; Gloeckner, Gliner, Tochterman, & Morgan, 2001; Merriam, 1995, 1998). Dimitrov and Runril stated, "External validity is the degree to which the treatment effect can be generalized across populations, settings, treatment variables, and measurement instruments" (p. 1). External validity can be claimed if the sample used in the study, or the population from which the sample is drawn, has a degree of uniqueness in their makeup vis-à-vis other populations to which the results may be applied. Dimitrov and Runril explained that threats to external validity include the interaction effects of selection biases and treatment, the reactive interaction effect of pretesting, the reactive effect of experimental procedures, and multiple-treatment interference.

Interaction effects of selection biases relate to the effects selection of subjects has on generalizability (Sunal et al., 2003). The self-selection characteristics of the two class types and the makeup of the student population made interaction effects a threat that must be recognized and considered in this study. The interaction effects threat also relates to the possibility that a pretest may affect outcomes. Since a pre-test was not used in this study, this threat was negligible. Next, the threat of interaction effects of experimental arrangements relates to the study conditions. Natural settings, such as the normal class environment used in this research, helped minimize this threat. Multiple-treatment interference relates to several variables interacting at the same time. Indeed, this is a significant threat to the conclusions that may be drawn from the results and must be considered when examining the conclusions.

Reliability

The degree to which the results of the instruments used in a study are consistent from administration to administration is the reliability of the study (Frankel & Wallen, 2006). As Aldridge (2003) put it

> Reliability is an accepted criterion for establishing research credibility in many scientific fields, and rests upon the assumption that repeated and objective measurement can ultimately determine whether a phenomenon is stable. Although this assumption rests on

> a shaky foundation since, as any dart player can attest, consistently achieving the same result is not necessarily the same as achieving the correct result. In certain types of studies, replicable results are not even a viable option. …. It is possible however, to strive for accuracy by collecting and analyzing data in such a manner that it more closely reflects the actual and unique circumstances of the study. (p. 79)

The instruments used in this study were the READI to measure student characteristics and standard multiple choice tests to measure student success. The reliability of the READI was attested by the provider of the measure, Decade Consulting, and substantiated by research on the measurement instrument discussed earlier in Chapter 2 (Decade Consulting, 2009a). Student success was measured by using the same objective tests and grade calculations in each class.

Sample Selection

Fraenkel and Wallen (2006) defined a target population as a "group to which the researcher would like the results of a study to be generalizable" (p. 92). The target population is rarely available for study and "the population for which the researcher is able to generalize … is the accessible population" (p. 93). The target population for this study was the approximately 150,000 technical college students seeking certificates, diplomas, and degrees from the Technical College System of Georgia (TCSG) annually (DTAE, 2005). The accessible population for this study was students enrolled in a diploma or degree program requiring a mathematics course, online or face-to-face, at a nationally accredited technical college of the TCSG, located in northern Georgia.

A combination of criterion and opportunistic sampling was used in this study. "In criterion sampling, as its name suggests, the sample is selected based on pre-established criteria" (Aldridge, 2003, p. 71). Participants in this study were technical college students who enrolled in face-to-face and online mathematics courses. For logistical reasons, they were limited to full or part-time students at Lanier Technical College.

The pool of subjects for the study was technical college students enrolled at any of the five campuses of Lanier Technical College: the Oakwood campus Oakwood, Georgia; the Forsyth Campus near Cumming, Georgia; the Winder campus in Winder, Georgia; the Jackson Campus in Commerce, Georgia; and the Dawson Campus near Dawsonville, Georgia. Lanier Technical College serves as the leading workforce development resource for the Georgia counties of Banks, Barrow, Dawson, Forsyth, Hall, Jackson, Lumpkin, and north Fulton. The served areas range from rural to urban. The college provides career-technical education programs leading to associate of applied science degrees, diplomas, and technical certificates of credit; customized business and industry training and economic development services; continuing education for technical and professional development; and adult literacy and education services to these counties (Lanier Technical College, 2008). The student body exceeds 3000 students per quarter. Demographics of the college and student body are provided at Appendix C. The college has a full time instructional staff of 208 (Lanier Technical College, 2008). Each quarter, more than 600 students enroll in mathematics classes taught by two full time mathematics instructors and six to ten adjunct instructors. About 43% of these students are enrolled in developmental mathematics classes (also called Learning Support classes). According to the Lanier Technical College BANNER student information system, of the remaining credit classes, about 78% are diploma level and 22% degree level.

The sample for this study consisted of all Lanier Technical College students enrolled during the fall quarter of 2008 and winter quarter of 2009 in the general college mathematics course MAT 1012, Foundations of Mathematics. The MAT 1012 course is required by 26 of the 39 programs of study at Lanier Technical College, which lead to diplomas or degrees. This 10-

week course emphasizes the application of basic mathematical skills in the solution of occupational and technical problems. Topics included in the course are fractions, decimals, percents, ratios and proportions, measurement and conversion, formula manipulation, technical applications, and basic statistics. The standards for this course are in Appendix D. This course was selected because it satisfies the mathematics requirement for over two-thirds of all diploma students enrolled in the college. Around 200 students typically enroll in the general college mathematics course at this college each fall quarter. Of these, about 46% register for online classes and 54% for face-to-face instruction.

This study used the earned or assigned grade to differentiate between successful and unsuccessful students. Each online or face-to-face student taking MAT 1012 may earn a letter grade of A, B, C, D or F. Students may also withdraw from the class with an assigned grade of W, meaning no grade is assigned, or an assigned grade of WP or WF, meaning the student was either passing the course or failing the course at the time of withdrawal. Finally, a student could be assigned a grade of I, meaning incomplete because they did not complete the course during the prescribed period of time (quarter) allotted. An earned grade of C or better in a class at a technical college would be a 70% average grade or higher (TCSG, 2008a). This grade is required for the class to be transferable within the TCSG system. For this reason, this measure is used to determine whether a student is successful or unsuccessful in a class.

Using fall 2007 summary numbers retrieved from BANNER, 73% of the online students were successful in the class and 78% of the face-to-face students were successful. Although sampling took place at multiple campuses of a single institution, the results of this study may not be generalizable to other technical colleges.

Data Collection Instrument

There are no limits to the kinds of instruments that can be used in a causal-comparative study (questionnaire, surveys, sampling). However, the basic causal-comparative design involves selecting groups that differ on a particular variable of interest and then comparing them on another variable or variables (Fraenkel & Wallen, 2006). In this study, the groups were successful and unsuccessful students in face-to-face mathematics classes, and successful and unsuccessful students in online mathematics classes. The BANNER system, where student grades are recorded for all courses, was the collection instrument for identifying successful and unsuccessful students.

In addition, each student in the MAT 1012 class in this study completed an inventory instrument called Readiness for Education at a Distance Indicator (READI) as required by the syllabus for that course. The particular variables of interest were the following elements as collected and evaluated by READI: preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency.

The BANNER student information system and the READI were the collection tools for this research. The president of the college granted permission to use this data (see Appendix E). Both instruments identified students by name. The BANNER student information system was the data source for student grades and is available to all instructors at Lanier Technical College. The Georgia Virtual Technical College provides the READI as a student self-diagnostic tool. The READI was accessible to both online and face-to-face students through the college's local area network and over the Internet through the college's Web page. An example of the access procedures for the READI, the READI instrument, and the individual READI report is provided in Appendix F.

READI measures and provides an individual report to each student on his or her preferred learning styles, computer information systems competency (labeled technical competency in the report), on-screen reading ability (labeled on-screen reading speed and comprehension in the report), and keyboarding proficiency (labeled typing speed and accuracy in the report). The data collected by, and presentation formats of, these areas, in the order given above, are explained below.

First, the seven learning styles were measured (Decade Consulting, 2009c). Each learning style was assigned a numerical value between a low of one to a high of 20 to indicate its relative dominance.

Computer information systems competency, a combination of technical, computer, and internet competency combined with technical knowledge, was the second area assessed. Students answered various questions relating to computer information systems competence. They received an overall numerical score for computer information systems competency ranging from a low of zero to a high of 100. They also received a score for the sub-component of technical knowledge. After these reports of percents and numerical scores, a written assessment was given to the student on her or his technology usage, technology vocabulary, and personal computer/Internet ability. In addition, a written evaluation was given of a responder's answers to questions asked in the assessment (Decade Consulting, 2009c).

The next area assessed was on-screen reading ability. For this area, the United States average adult reading speed for English prose text is about 250 to 300 words per minute. Research shows that reading is around 25% slower from a computer screen than from paper. To measure reading comprehension, students answered questions based on a text they were given to read within a specified time. READI then calculated a percent score based on the speed and accuracy of answers. A reading comprehension of 50% indicates a "below average reader," 60% "average reader," 80% "good reader," and 85% "excellent, accomplished reader" (Decade Consulting, 2009c).

The final area measured was keyboarding proficiency. The typist rate is 50 to 60 words per minute in the average workplace, and the average Web surfer rate is 30 words per minute. The student was provided a passage to type, and READI calculated typing speed and errors. Results provided include a gross word per minute rate, a character per minute rate, the total number of errors, a net score, and a combined percent measure of accuracy. The formula used was to divide the number of words by the number of seconds and subtract for the number of errors (Decade Consulting, 2009c).

Data Collection

The study began by administering the READI instrument to collect preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency data on all mathematics students enrolled in the general college mathematics course MAT 1012. For all MAT 1012 students, completion of the READI was an initial requirement of the course (see the Lanier Technical College President Authorization Letter to Conduct Research at Appendix E). The READI instrument was hosted on the college school network and available to all students via the school's local area network and the Internet (see Appendix F). For online students this was the first scheduled part of their class in their online course. For face-to-face students, instructors provided the students time on the first day of the class to complete the READI instrument. Late registrants to classes took the READI on their first day of attendance. The results of the READI were automatically recorded and immediately available to the instructors and the researcher through the READI database. All mathematics instructors employed at the college were required to ensure that students completed the READI instrument during the first week of the quarter in which the mathematics class was being taken (Appendix E). The requirement was specified in the course syllabus and was usually completed the first day of class for all students except late registrants to the class.

Class data required for this study was collected at the end of the quarter. Student grades were obtained by the researcher from BANNER, the official TCSG academic record keeping system. Approval to conduct this study was obtained from the President of Lanier Technical College (Appendix E). Approval from the University of Georgia's Institutional Review Board was obtained for this study in order to survey human subjects (Appendix G).

Data Analysis

For the purposes of this study, Predictive Analytic Software (PASW) 17 (formerly, Statistical Package for the Social Sciences 17) was used to perform data analysis (SPSS, 2009). A unique identifier was created and entered into the program for each student. Whether the student took MAT 1012 in online or face-to-face mode (the independent variable or treatment) and whether the student was successful or not (the resulting level) was also entered. The numerical data collected by READI for each measured area under study for each student was entered into the software as well. The statistical software calculated the mean scores for the students in each treatment and each level (independent variables) under study for each of the areas measured (dependent variables) and compared them using two-way ANOVA to ascertain any significant differences. A single mean was calculated for the dependent variables of computer information systems competency, on-screen reading ability, and keyboarding proficiency. However, for preferred learning styles question, a separate means comparison was performed for each of the seven identified learning styles rather than using the one predominant learning style of the student or attempting to create a composite of all the learning styles for each student.

For learning styles research, each learning style is often evaluated individually to glean information as to specific differences that might exist between two populations (Brown, Ingram, Stothers, & Thorp, 2006; Fahy & Ally, 2005; Wisehart, 2004). For example, Katzowitcz (2002) addressed the research question, "Are there statistically significant differences in learning styles among students based on age?" She used a causal-comparative study that, among other things, compared the learning styles of students at a technical college with respect to age level. A one-way ANOVA was conducted for each component of the learning styles measurement instrument used, with each component as the dependent variable and student age groups as independent variables. Statistically significant differences were found in five of the learning styles measured, four of which were verified by the post hoc Bonferonni technique, which compensates for the inflation of the alpha level resulting from multiple tests on the same set of data.

While several techniques have been used to develop a single composite score for a person's learning styles, none is generally accepted (Coffield, Moseley, Hall, & Ecclestone, 2004). Techniques that have been used include ignoring all but one or two select components (Walters, Egert, & Cuddihy, 2000), using an instrument with only two style classes into which learners are placed (DeTure, 2004), or identifying a subject only with their most prevalent or strongest learning style (Tucker, 1998). However, each learning style is more often evaluated individually in research. One reason is that no satisfactory consensus on how to derive a composite has been reached (Coffield et al.). Coffield et al. found that measures of reliability and validity of the testing instrument were chiefly derived through evaluation of each component element of their learning styles instrument. Instruments evaluated included Gregorc's (1982)

Mind Styles and multiple instruments produced by Dunn and Dunn (1993) to include their Learning Styles Questionnaire and Learning Styles Inventory. While the READI does include a composite learning style score, for the reasons given above, each of the styles was analyzed separately as dependent variables.

There were two independent or treatment variables in this study: membership in an online class or membership in a face-to-face class. Each has two levels of outcome, success or lack of success in the class, resulting in a *factorial design* (Hurlburt, 2003). With two treatments and two levels for each treatment, this is then a 2×2 factorial study. This study also had several dependent variables. The seven components of the learning styles characteristic (visual, social, physical, aural, verbal, solitary, and logical) were dependent variables. The computer information systems competency, on-screen reading ability, and keyboarding proficiency characteristics comprised three more. The independent or treatment variable of class format, along with the two outcome levels of success, comprise the groups in this 2×2 design.

Two-way ANOVA's were performed using the independent variables (treatments) and outcomes (levels) with each of the seven dependent variables. The treatments combined with the outcome levels comprised four groups of students: unsuccessful in online classes, successful in online classes, unsuccessful in face-to-face classes, and successful in face-to-face classes. The first seven analyses were based on the separate learning styles given as individual scores by READI and addressed the first research question. The remaining three analyses were based on a single numeric score given by READI. These addressed the remaining three research questions.

In this analysis, the main effect measured the extent to which the dependent variable differed from one level of one independent variable to another level of the same independent variable (Hurlburt, 2003). Referring to the treatments and levels, the two-way ANOVA identified row-wise (successful and unsuccessful face-to-face and successful and unsuccessful online) and column-wise (face-to-face and online successful and face-to-face and online unsuccessful) main effects. This analysis also tested for interaction effects (Hurlburt). This is known as factorial design.

The factorial design "allows a researcher to study the interaction of an independent variable with one or more other variables, sometimes called moderator variables" (Fraenkel & Wallin, 2006, p. 280). An interaction occurs when the effectiveness of one treatment variable depends on the level of the other treatment variable. These other treatment variables are sometimes called moderator variables. "Moderator variables may be either treatment variables or subject characteristic variables" (p. 280). The main effect of a treatment variable on a dependent variable and the interaction effect between treatment variables are the two effects examined. The statistic partial Eta squared is an estimate of the degree of interaction (Becker, 1999). The PASW 17 statistical analysis program was used to provide the interaction statistic partial Eta squared as well as to evaluate the significance of interaction effects as well as of main effects.

Each of the areas of the READI used, preferred learning styles with its seven styles measurements, computer information systems competency, on-screen reading ability, and keyboarding proficiency, was based on previous research. The method of analysis of each of these areas paralleled those of this research. Where READI reported single numerical measures for a student, such as computer information systems competency, on-screen reading ability, and keyboarding proficiency, normal theory statistics were applied. Where READI reported several numerical measures corresponding to discrete components within a major category, such as the seven learning styles of the preferred learning styles category, normal theory statistics was applied to each measured learning style. These numerical values were used to calculate means for each of the groups of students for each of the measured items.

For each dependent variable in Table 4, a series of two-way analysis of variance procedures were used to determine whether there were significant differences among the means of the four groups, successful and unsuccessful face-to-face mathematics students, and successful and unsuccessful online mathematics students, on the subscale scores of the READI at the .05 level of significance. Because multiple analyses were performed, the possibility of increased Type I errors existed (Abdi, 2007). False positive (Type I error) results are those that are unduly found to be significant when they are not. The Bonferroni correction procedure was applied to the statistical software program results to control for false positives that could arise by virtue of performing many tests. The purpose of correcting for multiple testing is to keep the overall error rate (or false positive rate) to less than the specified p-value cutoff.

Summary

This research used data obtained from the READI, as identified above, and the grade results obtained from mathematics students in face-to-face and online mathematics classes. The study used a causal-comparative approach to ascertain whether there were significant differences in the characteristics of preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency among technical college mathematics students who fell into one of four groups: successful in online classes, unsuccessful in online classes, successful in face-to-face classes, and unsuccessful in face-to-face classes. An arithmetic mean was calculated on each of the groups for each of the measured elements within these characteristics. A two-way ANOVA was performed on each of these to determine whether there were significant differences.

The Bonferroni correction procedure was applied to compensate for a potential increase in false positive difference errors due to the performance of multiple tests.

This research was causal-comparative in nature. Groups and outcomes were evaluated in situ, or as they were found, and variables in the study were not controlled by the researcher. As a result, evidence for causation is weaker than in an experimental design where groups and factors are controlled.

CHAPTER 4

FINDINGS OF THE STUDY

Introduction

This chapter presents the findings resulting from analysis of data in the study. First is a summary of the data collected for the study. Next are a discussion of the data analysis procedures and a presentation of the results of the data analysis of each research question. The final section summarizes the findings.

The purpose of this study was to examine differences in preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency of technical college mathematics students in online and face-to-face versions of a basic mathematics course (MAT 1012 Foundations of Mathematics) at a nationally accredited technical college of the TCSG, located in northern Georgia. These students were comprised of face-to-face class students who were successful, face-to-face class students who were unsuccessful, online class students who were successful, and online class students who were unsuccessful in the basic mathematics class. Students were considered successful if they achieved a grade of C (70%) or better. That grade is the minimum requirement for a class to be transferable within the TCSG system. Students achieving any other grade were considered unsuccessful. The research questions that guided the study were:

1. Are there statistically significant differences in the preferred learning styles of successful and unsuccessful face-to-face and online students in a basic mathematics course?

2. Is there a statistically significant difference in the computer information system competency of successful and unsuccessful face-to-face and online students in a basic mathematics course?

3. Is there a statistically significant difference in the on-screen reading ability of successful and unsuccessful face-to-face and online students in a basic mathematics course?

4. Is there a statistically significant difference in the keyboarding proficiency of successful and unsuccessful face-to-face and online students in a basic mathematics course?

Sample Data

Two hundred eighty-eight subjects participated fully in this study. All participants were students at a technical college in the state of Georgia in the United States. All students were enrolled in the basic mathematics course, MAT 1012 Foundations of Mathematics, during the fall quarter of 2008 or the winter quarter of 2009. All students were also tasked to complete the READI assessment at the beginning of the classes. MAT 1012 was offered in two formats, face-to-face and online. Both the face-to-face and online classes used the same textbooks, assignments, and grading.

In this study, there were 24 separate majors represented by the 288 students in the sample. There were 18 class sections, four online and 14 face-to-face, taught by ten instructors, eight of whom were adjuncts. There were 97 students in online classes and 191 in face-to-face classes. By gender, the sample had 194 female and 94 male students. The average ratio of female to male students in face-to-face class was 2.3. The average ratio in online class was 1.7. The overall ratio of female students to male students was 2.1. The average ratio of successful to unsuccessful students in face-to-face class was 4.2. The average ratio in online class was 3.7. Of the 288 students, there were 154 successful face-to-face students and 75 successful online students. The overall ratio of student success to lack of success was 3.9. The ages ranged from 18 to 67. The median age was 23 and the average age was 27. The median age of face-to-face students was 24 and the average age was 27.9. For online students 23 was the median and 27.4 was the average.

Face-to-face students attended three 65-minute mathematics classes weekly for ten weeks. Online students had the same length of time to complete their class. Automated homework and testing was used for both online and face-to-face class formats. During the fall quarter there were 163 students enrolled in the course. Of these, one student opted out of the study and 147 completed all parts of the READI assessment. During the winter quarter there were 176 students enrolled in the course. Of these, one student opted out of the study and 141 completed all parts of the READI assessment.

Permission was requested, and granted, from the University of Georgia's Institutional Review Board to survey human subjects. An Opt-out statement, provided by the IRB, was emailed to all MAT 1012 students through the ANGEL course portal used for all classes after grades were submitted each quarter of the study (Appendix G).

In the ANOVA design, groups based on treatment (face-to-face or online class format) and outcome levels (successful and unsuccessful) were identified for a 2 x 2 factorial study of the characteristics identified in the research questions. Further, seven distinct learning style components of the learning style preference characteristic were identified. A two-way analysis of variance (ANOVA) was used for each dependent variable. The dependent variables were the visual, social, physical, aural, verbal, solitary, and logical learning styles; computer information systems competency; on-screen reading ability; and keyboarding proficiency.

Data Analysis Procedures

The two-way analysis of variance was performed using the general linear model (GLM). The GLM investigates interactions between factors as well as the effects of individual factors on the distribution of dependent variables (SPSS, 2009). The population was divided into groups or cells by factor variables. Estimated marginal means gave estimates of predicted mean values for the cells in the model, and interaction plots of these means allowed visualization of their relationships.

In this study, four characteristics of technical college mathematics students were measured: preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency in a basic mathematics course. Two class formats were available for the students, face-to-face and online. In addition, there were two possible outcomes for the student, being successful or being unsuccessful in the course. The four combinations of format and outcome comprised the cells of the 2 x 2 analysis.

Since this study took place ex post facto, the number of cases in each cell was not guaranteed. Thus, the design was unbalanced. A design is balanced if each cell in the model contains the same number of cases. However, both balanced and unbalanced models can be tested using the GLM procedure (SPSS, 2009). According to Cue (2006) Type I, II, or III marginal sums of squares for a factor can be used in the analysis. "[Type III] is corrected for as many other factors in the model as possible" (Cue, p. 27). Type III Sums of Squares provide estimates that are not a function of the frequency of observations in any group, i.e., for unbalanced data structures, where we have unequal numbers of observations in each group; the groups with more observations do not per se have more importance than group(s) with fewer observations (Cue). For the GLM, Type III is the default (SPSS, 2009).

The effects of factor variables on the means of each dependent variable were tested by this procedure using the F statistic. First, descriptive statistics were identified for each variable in the test. Then, Levene's test of equality of error variances was used to test the null hypothesis that the error variance of the dependent variable was equal across groups. A univariate analysis of variance for each dependent variable was then completed. Additionally, where an overall F test showed significance, a post hoc test was identified to be used to evaluate differences among specific means.

The analysis of variance tests conducted provided comparisons for each of the ten dependent variables. Due to the multiple comparisons made, a Bonferonni correction was applied to the alpha or critical significance level for all tests (Abdi, 2007). A 0.005 effective alpha was used (using $\alpha = 0.05$, the effective alpha is approximately $\alpha/10 = 0.005$).

With more than one independent variable specified, PASW performs several multivariate analysis of variance tests to ascertain interaction. These multivariate tests focus on the independents and their interactions where the F test focuses on the dependents. The multivariate analysis of variance tests used were Pillai’s trace, Wilks’ lambda, Hotelling’s trace, and Roy’s largest root criterion with approximate F statistic (SPSS, 2009).

The GLM procedure did not indicate significant differences based on class format and success status individually. In addition, no significant interaction of the factors was noted.

Summary of Results

A series of ten two-way analyses of variance were performed for the four research questions. For the research question regarding preferred learning styles, an analysis was completed for each of the learning style components measured, as no satisfactory composite measure was available. The alpha level was 0.05 for each analysis. Applying the Bonferonni correction for ten dependent variables the effective alpha is 0.05/10 = 0.005. A value of less than 0.005 in the Sig column of the tables provided for each analysis would indicate a significant difference. In these tables, Format*Success refers to the interaction of these two independent variables.

Preferred learning styles

Visual preferred learning style. A 2 x 2 ANOVA was conducted to evaluate the relationship of class format and student success with the visual preferred learning style in a basic technical college mathematics course. The means, standard deviations, and numbers of students of the visual learning style as a function of the two factors are provided in Table 3 and the analysis of variance in Table 4.

Table 3
Descriptive Statistics for the Dependent Variable Visual Learning Style

Format	Success	Mean	Std. Deviation
Online	Unsuccessful	5.45	2.304
	Successful	5.43	2.273
Face-to-face	Unsuccessful	5.32	2.667
	Successful	5.11	2.419

Table 4
Analysis of Variance for Dependent Variable Visual Learning Style

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Format	2.160	1	2.160	.373	.542
Success	.633	1	.633	.109	.741
Format * Success	.375	1	.375	.065	.799

The ANOVA for the visual learning style indicated no significant interaction between format and success, $F(3, 284) = .065$, $p = .799$. There were also no significant main effects for format, $F(3, 284) = .373$, $p = .542$, and success, $F(3, 284) = .109$, $p = .741$.

Social preferred learning style. A 2 x 2 ANOVA was conducted to evaluate the relationship of class format and student success with the social preferred learning style in a basic technical college mathematics course. The means and standard deviations of the learning style as a function of the two factors are provided in Table 5 and the analysis of variance in Table 6.

Table 5
Descriptive Statistics for the Dependent Variable Social Learning Style

Format	Success	Mean	Std. Deviation
Online	Unsuccessful	6.95	2.149
	Successful	7.24	1.815
Face-to-face	Unsuccessful	7.92	1.498
	Successful	6.92	1.980

Table 6
Analysis of Variance for Dependent Variable Social Learning Style

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Format	4.437	1	4.437	1.234	.268
Success	5.583	1	5.583	1.552	.214
Format * Success	17.994	1	17.994	5.004	.026

The ANOVA indicated no significant interaction between format and success, $F(3, 284) = 5.004$, $p = .026$. There were no significant main effects for format, $F(3, 284) = 1.234$, $p = .268$, and success, $F(3, 284) = 1.552$, $p = .214$.

Physical preferred learning style. A 2 x 2 ANOVA was conducted to evaluate the relationship of class format and student success with the physical preferred learning style in a basic technical college mathematics course. The means and standard deviations of the learning style as a function of the two factors are in Table 7 and the analysis of variance is in Table 8.

Table 7
Descriptive Statistics for the Dependent Variable Physical Learning Style

Format	Success	Mean	Std. Deviation
Online	Unsuccessful	6.91	2.045
	Successful	6.47	1.989
Face-to-face	Unsuccessful	6.14	1.960
	Successful	6.19	1.976

Table 8
Analysis of Variance for Dependent Variable Physical Learning Style

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Format	11.996	1	11.996	3.052	.082
Success	1.641	1	1.641	.418	.519
Format * Success	2.661	1	2.661	.677	.411

The ANOVA indicated no significant interaction between format and success, $F(3, 284) = .677$, $p = .411$. Also, there were no significant main effects for format, $F(3, 284) = 3.052$, $p = .082$, and success, $F(3, 284) = .418$, $p = .519$.

Aural preferred learning style. A 2 x 2 ANOVA was conducted to evaluate the relationship of class format and student success with the aural preferred learning style in a basic technical college mathematics course. The means and standard deviations of the learning style as a function of the two factors are provided in Table 9 and the analysis of variance in Table 10.

Table 9
Descriptive Statistics for the Dependent Variable Aural Learning Style

Format	Success	Mean	Std. Deviation
Online	Unsuccessful	6.55	1.920
	Successful	7.04	2.196
Face-to-face	Unsuccessful	7.05	2.260
	Successful	6.44	2.126

Table 10
Analysis of Variance for Dependent Variable Aural Learning Style

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Format	.101	1	.101	.022	.883
Success	.168	1	.168	.036	.849
Format * Success	13.433	1	13.433	2.912	.089

The ANOVA indicated no significant interaction between format and success, *F*(3, 284) = 2.912, p = .089. Also, there were no significant main effects for format, *F*(3, 284) = .022, p = .883, and success, *F*(3, 284) =.036, p = .849.

Verbal preferred learning style. A 2 x 2 ANOVA was conducted to evaluate the relationship of class format and student success with the verbal preferred learning style in a basic technical college mathematics course. The means and standard deviations of the learning style as a function of the two factors are provided in Table 11 and the analysis of variance in Table 12.

Table 11
Descriptive Statistics for the Dependent Variable Verbal Learning Style

Format	Success	Mean	Std. Deviation
Online	Unsuccessful	5.45	1.945
	Successful	6.31	2.348
Face-to-face	Unsuccessful	6.89	2.145
	Successful	5.97	2.269

Table 12
Analysis of Variance for Dependent Variable Verbal Learning Style

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Format	13.221	1	13.221	2.606	.108
Success	.047	1	.047	.009	.924
Format * Success	33.939	1	33.939	6.690	.010

The ANOVA indicated no significant interaction between format and success, *F*(3, 284) = 6.690, p = .010. There were also no significant main effects for format, *F*(3, 284) = 2.606, p = .108, and success, *F*(3, 284) =.009, p = .924.

Solitary preferred learning style. A 2 x 2 ANOVA was conducted to evaluate the relationship of class format and student success with the solitary preferred learning style in a basic technical college mathematics course. The means and standard deviations of the learning style as a function of the two factors are provided in Table 13 and the analysis of variance in Table 14.

Table 13
Descriptive Statistics for the Dependent Variable Solitary Learning Style

Format	Success	Mean	Std. Deviation
Online	Unsuccessful	5.41	1.764
	Successful	6.21	2.009
Face-to-face	Unsuccessful	6.16	1.993
	Successful	5.88	1.776

Table 14
Analysis of Variance for Dependent Variable Solitary Style

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Format	1.878	1	1.878	.539	.463
Success	2.915	1	2.915	.836	.361
Format * Success	12.866	1	12.866	3.692	.056

The ANOVA indicated no significant interaction between format and success, $F(3, 284) = 3.692$, $p = .066$. There were also no significant main effects for format, $F(3, 284) = .539$, $p = .463$, and success, $F(3, 284) =.836$, $p = .361$.

Logical preferred learning style. A 2 x 2 ANOVA was conducted to evaluate the relationship of class format and student success with the logical preferred learning style in a basic technical college mathematics course. The means and standard deviations of the learning style as a function of the two factors are provided in Table 15 and the analysis of variance in Table 16.

Table 15
Descriptive Statistics for the Dependent Variable Logical Learning Style

Format	Success	Mean	Std. Deviation
Online	Unsuccessful	5.68	2.124
	Successful	5.92	2.288
Face-to-face	Unsuccessful	6.51	2.388
	Successful	6.29	2.022

Table 16
Analysis of Variance for Dependent Variable Logical Learning Style

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Format	15.533	1	15.533	3.360	.068
Success	.001	1	.001	.000	.987
Format * Success	2.352	1	2.352	.509	.476

The ANOVA indicated no significant interaction between format and success, $F(3, 284) = .509$, $p = .476$. There were no significant main effects for format, $F(3, 284) = 3.360$, $p = .068$, and success, $F(3, 284) =.000$, $p = .987$.

Computer information systems competency

A 2 x 2 ANOVA was conducted to evaluate the relationship of class format and student success relative to computer information systems (CIS) competency in a basic technical college mathematics course. The means and standard deviations as a function of the two factors are provided in Table 17 and the analysis of variance in Table 18.

Table 17
Descriptive Statistics for the Dependent Variable Computer Information System Competency

Format	Success	Mean	Std. Deviation
Online	Unsuccessful	66.73	13.871
	Successful	66.92	14.553
Face-to-face	Unsuccessful	70.38	11.209
	Successful	65.69	13.762

Table 18
Analysis of Variance for Dependent Variable Computer Information System Competency

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Format	63.413	1	63.413	.338	.561
Success	219.114	1	219.114	1.169	.280
Format * Success	258.283	1	258.283	1.379	.241

The ANOVA indicated no significant interaction between format and success, $F(3, 284) = 1.379$, $p = .241$. In addition, there were no significant main effects for format, $F(3, 284) = .338$, $p = .561$, and success, $F(3, 284) = 1.169$, $p = .280$.

On-screen reading ability

A 2 x 2 ANOVA was conducted to evaluate the relationship of class format and student success with on-screen reading ability in a basic technical college mathematics course. The means and standard deviations of on-screen reading ability as a function of the two factors are provided in Table 19 and the analysis of variance in Table 20.

Table 19

Descriptive Statistics for the Dependent Variable On-screen Reading Ability

Format	Success	Mean	Std. Deviation
Online	Unsuccessful	60.18	20.857
	Successful	63.99	17.199
Face-to-face	Unsuccessful	62.49	18.144
	Successful	64.76	17.312

Table 20

Analysis of Variance for Dependent Variable On-screen Reading Ability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Format	102.618	1	102.618	.328	.567
Success	400.216	1	400.216	1.281	.259
Format * Success	25.412	1	25.412	.081	.776

The ANOVA indicated no significant interaction between format and success, $F(3, 284) = .081$, $p = .776$. There were no significant main effects for format, $F(3, 284) = .328$, $p = .567$, and success, $F(3, 284) = 1.281$, $p = .259$.

Keyboarding competency

A 2 x 2 ANOVA was conducted to evaluate the relationship of class format and student success with keyboarding competency in a basic technical college mathematics course. The means and standard deviations of keyboarding competency as a function of the two factors are provided in Table 21 and the analysis of variance in Table 22.

Table 21

Descriptive Statistics for the Keyboarding Competency

Format	Success	Mean	Std. Deviation
Online	Unsuccessful	22.23	7.994
	Successful	21.88	10.993
Face-to-face	Unsuccessful	21.92	10.032
	Successful	22.10	10.730

Table 22

Analysis of Variance for Dependent Variable Keyboarding Competency

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Format	.090	1	.090	.001	.977
Success	.309	1	.309	.003	.958
Format * Success	2.995	1	2.995	.027	.870

The ANOVA indicated no significant interaction between format and success, $F(3, 284) = .027$, $p = .870$. There were no significant main effects for format, $F(3, 284) = .001$, $p = .977$, and success, $F(3, 284) = .003$, $p = .958$.

Conclusion

In conclusion, there were no significant main effects for any of the variables tested. There were significant interaction effects for two components of the learning style preferences, social and verbal. In seeking a causative relationship, a post hoc examination of the significant interaction effect found by the ANOVA for the social preferred learning style revealed significantly lower scores for successful face-to-face students than for unsuccessful face-to-face students. However, a post hoc examination of the significant interaction effect found by the ANOVA for the verbal preferred learning style revealed no identifiable causative relationship.

CHAPTER 5

DISCUSSION

Introduction

This chapter provides a review of the rationale and theoretical framework for this study, a summary of the research and its results, and the limitations of the study. Following the summary and limitations, a discussion of the implications of the study is presented. Recommendations for future research are also made. The chapter is concluded by a consideration of the significance of the study.

Rationale and Theoretical Framework

The Technical College System of Georgia (TCSG), through the Georgia Virtual Technical College (GVTC), has identified three categories of Internet use in connection with classes: online, hybrid, and Web-enhanced (Georgia Virtual Technical College, 2002). While courses in the hybrid and Web-enhanced categories use predominantly the traditional face-to-face format for instruction, courses in the online category are delivered completely over the Internet.

There are two streams of thought on how students learn over the Internet. One maintains that students learn the same way in online classes as in face-to-face classes, and the other that student learning in online classes differs from that of face-to-face. Regardless of the approach taken, the Western Cooperative for Educational Telecommunications (WCET) found most studies to date reflected no significant difference in constructs being analyzed between face-to-face and online classes (2006). Specific comparisons of online and face-to-face classes in mathematics have come to the same no significant difference conclusion identified above (Mascuilli, 2004).

One of the essential content areas within the technical college programs of study is the mathematics component known as numeracy. “Virtually everyone uses quantitative tools in some way in relation to their work, if only to calculate their wages and benefits" (Steen, p. 1). All TCSG students in career diploma programs must take a basic mathematics course in order to complete the program successfully. She or he can chose to learn mathematics exclusively in face-to-face classes; however, with the growing use of online classes in technical colleges, many technical college students can be expected to learn mathematics in online courses. The workforce preparation programs of study rely more and more on these online mathematics classes.

Intelligence may arguably be the primary factor in a student’s ability to learn mathematics. Gardner's (1983) work in multiple intelligences provided a theoretical foundation underlying a portion of this study. Research has shown that people have different preferred learning styles based on these multiple intelligences (Gardner, 1999; Aragon, Johnson, & Shaik, 2001; Engelbrecht & Harding, 2005b). Thus, in understanding how adult technical college students learn mathematics online, one critical factor to be assessed was the students’ preferred learning styles. However, there is a paucity of quantitative research relating this and other student characteristics to their success or lack of it in online and face-to-face mathematics classes. This made a quantitative study relating the characteristics required for technical college students to achieve success in basic mathematics within either format valuable.

The Technical College System of Georgia routinely uses an evaluation instrument known as the Readiness for Education at a Distance Indicator (READI) (GVTC, 2009b). Preferred learning styles are assessed by this instrument. Hence, the use of the READI was practicable for this study. In addition, the READI also assesses computer information systems competency, on-screen reading ability, and keyboarding proficiency as factors that indicate a student is ready for online classes.

Summary of Research

This study examined differences in preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency of technical college mathematics students in a basic mathematics course (MAT 1012 Foundations of Mathematics). It also identified successful and unsuccessful face-to-face and online students in this numeracy course. Analysis of variance (ANOVA) for multiple dependent variables by one or more factor variables or covariates was used (SPSS, 2009). The sample population was divided into groups or cells by factor variables. The combinations of class format and success formed four groups or factors for the analyses. Data was obtained from the BANNER student database system for data on student success. Data was obtained from the READI database for student preferred learning styles, computer information systems competency, on-screen reading ability, and keyboarding proficiency. Interactions between factors and the effects of individual factors were evaluated.

It is possible that the personal characteristics of the students themselves accounted for some observed relationships. This is the issue of internal validity. Although the internal drives and motivations of the students was not assessed, the data on their external characteristics, provided in Chapter 4, suggests no striking differences among the groups in the study. However, this does not abrogate the fact that the students self-selected their class.

There was also the possibility that differences in class delivery accounted for some of the observed relationship. Treatment fidelity addresses the degree to which treatments are applied equally to all subjects. Insuring fidelity can be a daunting task. For example, in this study each class had the same syllabus, weekly lesson plans, and tests. Online classes were all designed by one of the two full time instructors and delivered by that instructor and one adjunct instructor. The materials and assignments were the same for all face-to-face classes. The tests were all multiple choice and all administered at the same time in each class. The final exam for the class was an objective exam designed to test the attainment of the competencies required for the course (Appendix D). All ten instructors teaching the classes had a minimum of a bachelor's degree in mathematics. They were trained by the senior instructor on the use of automated systems for online and face-to-face classes and operated under the direct supervision of the full time instructors during the period of the research. Nevertheless, as ten separate instructors were involved, ensuring they taught each class in exactly the same way was impossible to control. Thus, fidelity could not be absolutely assured.

Additional threats to internal validity were location, instrumentation, and loss of subjects . The study used multiple campuses with differing local populations from which to draw their students to minimize location bias. Instrumentation bias was lessened by using the same tests for all classes to evaluate success and use of READI. In addition, all mathematics classes used in this study followed a common competency standard on which the objective tests were based and the same grading scheme. The loss of subjects threat was minimized by incorporating these losses in the design. Subjects who were lost were de facto not successful in the mathematics course they were taking. Intervention bias was negligible in that the only intervention was the students' completion of the READI instrument, which all students taking this courses were required to do by the course syllabus. Finally, researcher bias was reduced by having the only area of direct researcher intervention, the classroom, balanced by using multiple classes with different instructors and a common standard and grading scheme for all classes.

Considering external validity, interaction effects of selection biases was a concern. These relate to the effects selection of subjects has on generalizability (Sunal et al., 2003). The self-selection characteristics of the two class types and the makeup of the student population made interaction effects a threat that must be recognized and considered in this study.

Addressing reliability, the instruments used in this study were the READI to measure student characteristics and standard multiple choice tests to measure student success. The reliability of the READI was attested by the provider of the measure, Decade Consulting, and substantiated by research on the measurement instrument discussed earlier in Chapter 2 (Decade Consulting, 2009a). Student success was measured by using the same objective tests and grade calculation in each class .

Research Results

This study identified no significant differences in the main effects of characteristics of the students in any group and no significant interaction effects. The first research question that guided this study sought to ascertain if there were statistically significant differences among these groups of successful and unsuccessful face-to-face and online students in the visual, social, physical, aural, verbal, solitary, and logical preferred learning styles. Previous research suggested differences should be expected (Aragon, Johnson, & Shaik, 2002). Nevertheless, in all of the two-way ANOVA analyses performed, no significant differences were found in the main effects for any of the seven learning styles analyzed.

For the three questions guiding this study concerning group differences in computer information systems competency, on-screen reading ability, and keyboarding proficiency, the analyses of the data provided by the READI found no significant difference among successful and unsuccessful technical college students in face-to-face and online basic mathematics classes. This result suggested that these characteristics may not be predictors of success in online technical college mathematics classes, nor may they be indicators of which format for learning mathematics a technical college student should employ.

Limitations of the Study

This study was limited to one of the many technical colleges in Georgia. Thus, the conclusions reached may not generally apply to all technical colleges. In addition, the study limited itself to comparison of only basic mathematics classes. Different results might be obtained were the study to encompass other academic or professional disciplines.

The instrument used in this study to measure student characteristics, the READI, is not the sole tool used in the educational community for identification of learning readiness. For example, the SORT tool, identified earlier, is generally used in the University System of Georgia for this same purpose. Use of a different instrument may result in different results.

The measure of success for students in this study is not the sole possible measure of student success. It was chosen because transferability of a class is recognized by the Technical College System of Georgia (TCSG) as indicating success. While the TCSG does establish standards for each course offered, the methods of measurement through subjective evaluation and objective testing are not absolute. Thus, different results may have been obtained depending on what measure of success was applied and by whom.

Finally, the choice of learning format for the basic mathematics class was not controlled in the study. Students have a choice of which class format they want. Thus, the class in which a student was enrolled was based on self-selection by the student. This introduced a lack of randomness that may have had an effect on the outcome of the study.

Implications for Practice and Research

The principal implication of this study was that there were no significant differences detected in the characteristics measured for successful face-to-face versus online technical college students in a basic mathematics class. This tended to conflict with some research, such as that by Engelbrecht and Harding (2005b), that found visual learners preferred technology, while verbal learners preferred a face-to-face interaction. However, it supported the more prevalent no significant difference conclusions regarding all face-to-face and online classes. In addition, it validated the decision to offer this class in both formats for the technical college student to acquire the numeracy skills needed for their occupational program of study.

While the lack of significance between learning style preferences based on class format and outcomes tended to affirm the decision of the technical college system to offer the basic numeracy course in both face-to-face and online formats, it does not necessarily affirm that decision in all areas. What holds for a basic numeracy class may not hold for another mathematics class such as quantitative skills and reasoning.

A basic numeracy class tends to be instructor focused with little requirement for deep analytical thought and interpersonal interaction by the student. A primary objective of the numeracy curriculum is the memorization of formulas and procedures. Another objective is the application of these formulas and procedures to solve problems. This level of complexity is easily achievable regardless of a preferred learning style. Only some areas, such as the solution of “word problems,” where systematic algorithms may not be available, involve a more complex degree of analysis and interpretation. However, even these objectives may not present a challenge to a student regardless of the student’s learning style preferences. On the other hand, other mathematics courses in the technical college curriculum may be more challenging.

Depending on the students learning style preferences, success may not be equally achieved in these classes whether face-to-face or online.

A quantitative skills and reasoning class involves interpretation of logical constructs, seeking information about the real world, and manipulation of that information to create representations of the real world using mathematics, perhaps favoring those students with a logical learning style preference.

This may also be the case when looking at computer information systems competency, on-screen reading ability, and keyboarding proficiency. The study found no significant difference among successful and unsuccessful technical college students in face-to-face and online basic mathematics classes. This affirmed the continued offering of the basic numeracy class in either face-to-face or online format with an expectation of equivalent results. Once again, different results might have been found had the subject matter of the mathematics classes under study been different.

For the computer information system competency question, the expectation was for successful online students to have a significantly higher competency score than unsuccessful online students based on the requirement to use computer technology more extensively in an online course than in face-to-face course. The results of this study showed successful and unsuccessful online students did not differ significantly from successful and unsuccessful face-to-face students in this competency for a basic numeracy class. A review of the technological tools an online student was required to manipulate revealed that the complexity faced was no more stringent than one would encounter surfing the Internet. It differed little from recording the solution to an arithmetic problem on the computer versus using pencil and paper in a traditional face-to-face class, . Perhaps this low degree of complexity accounted for the lack of significance. Different results might be found for a numeric skills and reasoning class that required use of more complex technology in online classes.

Both visualization and modeling software are used in the online quantitative skills and reasoning course mentioned earlier. These require understanding and manipulation of the graphical controls for these programs in an online class. The student in the online class must be able to use software to digitally input the complex mathematical symbols used in this class. This may advantage the student who has high computer information system competency skills, but disadvantage students with a lower skill. This could have an effect on the individual student's success in the course depending on the format the student chose, face-to-face or online.

In the on-screen reading ability comparison, the study found no significant differences among the groups. The subject matter of mathematical numeracy does not consist of large quantities of material that must be read. Generally, short mathematical rules are explained with examples of their application. This is coupled with computer-guided exercises in the case of the online course, and instructor directed exercises in the case of the face-to-face course. This may explain why there were no significant differences in outcomes among the groups.

Keyboarding proficiency results for the groups were also not significantly different. As with reading, the requirement for extensive keyboard entry for mathematics courses is not normally large. Students in online courses most often use their keyboards to enter numeric values on the computer screen, select options in multiple-choice questions, or query their instructor. In the latter, keyboard accuracy, or for that matter grammar, is not a high premium. For this reason, differences in student capabilities among the groups in this area may not have been measurably significant.

Perhaps a more important product of this study than its no significant difference result is the template it provides for further study. Within the TCSG, this study is easily replicated for any subject area. The data used by the study is routinely collected by BANNER, the common database used throughout the TCSG, and by the READI database. The data entered in the former is mandatory, while that entered in the latter is voluntary for the student. The principle requirements in data collection for a researcher using this template are assuring that students complete the READI evaluation and ensuring consistency and equivalency in the course content and delivery. While data analysis in this study was completed using PASW 17, other statistical data analysis software, such as SAS, can easily be used. However, caution must be used in applying this template. Each of the issues of validity and the limitations in the research discussed above must be taken into account. While the READI instrument is convenient to use, a researcher might consider using another instrument, such as the SORT used by the University System of Georgia. Also, while use of the grade recorded in BANNER may also be convenient, a researcher may determine that some other measurement of success should be used, such as specifically evaluating the achievement of competencies using the Southern Association of Colleges required student learning outcomes (SACS, 2008).

Recommendations for Further Research

Based upon the research results, limitations, and implications, the following recommendations for additional study are presented:

1. Repetition of this study at other technical colleges is suggested to provide results that are more generalizable.
2. Similar research should also be conducted for other academic disciplines such as English or psychology. While the mathematics discipline focusing on problem solving is similar in many ways to the medical and technology disciplines of the various occupations technical college students pursue, other disciplines less focused on problem solving and

more on reading and interactions, such as English or psychology in general education, are also important to the students' overall education. In addition, these later subjects require a different form of study and interaction than mathematics in either a face-to-face or online class format.

3. Further, similar research in the occupational programs of study, which are being offered more and more in both formats, is warranted. These disciplines, as in general education disciplines other than mathematics, have components that extend past problem solving and require a different form of action and interaction than mathematics in either a face-to-face or online class format as well.

Significance of the Study

Based on the results obtained in this study, there are no significant differences in the characteristics of successful or unsuccessful students in a basic mathematics numeracy classes regardless of the format used, face-to-face or online. If similar results are obtained in other course types, including occupational program courses, then it can be concluded that the delivery of classes in these disciplines is format independent. This study provided an outline for studies in those other disciplines. If the results of further studies demonstrate that technical college students have the same outcome whether their classes are taken over the Internet or in a face-to-face environment, this would further validate the commitment by the TCSG to offering occupational classes in both formats.

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APPENDICES

APPENDIX A

TYPES OF MULTIPLE INTELLIGENCES

Visual/Spatial Intelligence. Ability to perceive the visual. These learners tend to think in pictures and need to create vivid mental images to retain information. They enjoy looking at maps, charts, pictures, videos, and movies. Their skills include: puzzle building, reading, writing, understanding charts and graphs, a good sense of direction, sketching, painting, creating visual metaphors and analogies (perhaps through the visual arts), manipulating images, constructing, fixing, designing practical objects, interpreting visual images.

Verbal/Linguistic Intelligence. Ability to use words and language. These learners have highly developed auditory skills and are generally elegant speakers. They think in words rather than pictures. Their skills include: listening, speaking, writing, storytelling, explaining, teaching, using humor, understanding the syntax and meaning of words, remembering information, convincing someone of their point of view, analyzing language usage.

Logical/Mathematical Intelligence. Ability to use reason, logic and numbers. These learners think conceptually in logical and numerical patterns making connections between pieces of information. Always curious about the world around them, these learner ask lots of questions and like to do experiments. Their skills include: problem solving, classifying and categorizing information, working with abstract concepts to figure out the relationship of each to the other, handling long chains of reason to make local progressions, doing controlled experiments, questioning and wondering about natural events, performing complex mathematical calculations, working with geometric shapes.

Bodily/Kinesthetic Intelligence. Ability to control body movements and handle objects skillfully. These learners express themselves through movement. They have a good sense of balance and eye-hand co-ordination (e.g., ball play, balancing beams). Through interacting with the space around them, they are able to remember and process information. Their skills include:

dancing, physical co-ordination, sports, hands on experimentation, using body language, crafts, acting, miming, using their hands to create or build, expressing emotions through the body.

Musical/Rhythmic Intelligence. Ability to produce and appreciate music. These musically inclined learners think in sounds, rhythms and patterns. They immediately respond to music either appreciating or criticizing what they hear. Many of these learners are extremely sensitive to environmental sounds (e.g., crickets, bells, dripping taps). Their skills include: singing, whistling, playing musical instruments, recognizing tonal patterns, composing music, remembering melodies, understanding the structure and rhythm of music

Interpersonal Intelligence. Ability to relate and understand others. These learners try to see things from other people's point of view in order to understand how they think and feel. They often have an uncanny ability to sense feelings, intentions and motivations. They are great organizers, although they sometimes resort to manipulation. Generally, they try to maintain peace in group settings and encourage co-operation. They use both verbal (e.g., speaking) and non-verbal language (e.g., eye contact, body language) to open communication channels with others. Their skills include: seeing things from other perspectives (dual-perspective), listening, using empathy, understanding other people's moods and feelings, counseling, co-operating with groups, noticing people's moods, motivations and intentions, communicating both verbally and non-verbally, building trust, peaceful conflict resolution, establishing positive relations with other people.

Intrapersonal Intelligence. Ability to self-reflect and be aware of one's inner state of being. These learners try to understand their inner feelings, dreams, relationships with others, and strengths and weaknesses. Their skills include: Recognizing their own strengths and weaknesses, reflecting and analyzing themselves, awareness of their inner feelings, desires and dreams, evaluating their thinking patterns, reasoning with themselves, understanding their role in relationship to others. (READI, 2008a)

APPENDIX B

CHARACTERISTICS OF MULTIPLE INTELLIGENCES

The following are characteristics of the seven intelligences posited by Howard Gardner as compiled and presented by Laughlin (2006)

Characteristics of Linguistic Intelligence

- Listens and responds to the sound, rhythm, color, and variety of the spoken word.
- Imitates sounds, language, reading, and writing of others.
- Learns through listening, reading, writing, and discussing.
- Listens effectively, comprehends, paraphrases, interprets, and remembers what has been said.
- Reads effectively, comprehends, summarizes, interprets or explains, and remembers what has been read.
- Speaks effectively to a variety of audiences for a variety of purposes, and knows how to speak simply, eloquently, persuasively, or passionately at appropriate times.
- Writes effectively; understands and applies rules of grammar, spelling, punctuation, and uses an effective vocabulary.
- Exhibits ability to learn other languages.
- Uses listening, speaking, writing, and reading to remember, communicate, discuss, explain, persuade, create knowledge, construct meaning, and reflect upon language itself.
- Strives to enhance his or her own language usage.
- Demonstrates interest in journalism, poetry, storytelling, debate, speaking, writing, or editing.
- Creates new linguistic forms or original works of writing or oral communication.

Characteristics of Logical-Mathematical Intelligence

- Perceives objects and their function in the environment.

- Is familiar with the concepts of quantity, time, and cause and effect.
- Uses abstract symbols to represent concrete objects and concepts.
- Demonstrates skill at logical problem-solving.
- Perceives patterns and relationships.
- Poses and tests hypotheses.
- Uses diverse mathematical skills such as estimating, calculating algorithms, interpreting statistics, and visually representing information in graphic form.
- Enjoys complex operations such as calculus, physics, computer programming, or research methods.
- Thinks mathematically by gathering evidence, making hypotheses, formulating models, developing counter-examples, and building strong arguments.
- Uses technology to solve mathematical problems.
- Expresses interest in careers such as accounting, computer technology, law, engineering, and chemistry.
- Creates new models or perceives new insights in science or mathematics.

Characteristics of Bodily-Kinesthetic Intelligence

- Explores the environment and objects through touch and movement. Prefers to touch, handle, or manipulate what is to be learned.
- Develops coordination and a sense of timing.
- Learns best by direct involvement and participation.
- Remembers most clearly what was done, rather than what was said or observed.
- Enjoys concrete learning experiences such as field trips, model building, or participating in role play, games, assembling objects, or physical exercise.

- Shows dexterity in working by means of small or gross motor movements.
- Is sensitive and responsive to physical environments and physical systems.
- Demonstrates skill in acting, athletics, dancing, sewing, carving, or keyboarding.
- Demonstrates balance, grace, dexterity, and precision in physical tasks.
- Has the ability to fine-tune and perfect physical performance through mind and body integration.
- Understands and lives by healthy physical standards.
- May express interest in careers such as those of an athlete, dancer, surgeon, or builder.
- Invents new approaches to physical skills or create new forms in dance, sports, or other physical activities.

Characteristics of Spatial Intelligence

- Learns by seeing and observing.
- Recognizes faces, objects, shapes, colors, details, and scenes.
- Navigates self and objects effectively through space, as when moving one's body through apertures, finding one's way in a forest without a trail, moving a car through traffic, or paddling a canoe on a river.
- Perceives and produces mental imagery, thinks in pictures, and visualizes detail. Uses visual images as an aid in recalling information.
- Decodes graphs, charts, maps, and diagrams. Learns with graphic representation or through visual media.
- Enjoys doodling, drawing, painting, sculpting, or otherwise reproducing objects in visible forms.

- Enjoys constructing three-dimensional products, such as original objects, mock bridges, houses, or containers.
- Is capable of mentally changing the form of an object—such as folding a piece of paper into a complex shape and visualizing its new form, or mentally moving objects in space to determine how they interact with other objects, such as gears, turning parts of machinery.
- Sees things in different ways or from "new perspectives" such as the negative space around a form as well as the form itself or detects one form "hidden" in another.
- Perceives both obvious and subtle patterns.
- Creates concrete or visual representation of information.
- Is proficient at representational or abstract design.
- Expresses interest or skill in being an artist, photographer, engineer, videographer, architect, designer, art critic, pilot, or other visually-oriented careers.
- Creates new forms of visual-spatial media or original works of art.

Characteristics of Musical Intelligence

- Listens and responds with interest to a variety of sounds including the human voice, environmental sounds, and music, and organizes such sounds into meaningful patterns.
- Enjoys and seeks out opportunities to hear music or environmental sounds in the learning environment.
- Is eager to be around and learn from music and musicians.
- Responds to music kinesthetically by conducting, performing, creating, or dancing; emotionally through responding to the moods and tempos of music; intellectually through

discussing and analyzing music; and/or aesthetically by evaluating and exploring the content and meaning of music.

- Recognizes and discusses different musical styles, genres, and cultural variations. Demonstrates interest in the role music has and continues to play in human lives.
- Collects music and information about music in various forms, both recorded and printed, and may collect and play musical instruments including synthesizers.
- Develops the ability to sing and/or play an instrument alone or with others.
- Uses the vocabulary and notations of music.
- Develops a personal frame of reference for listening to music.
- Enjoys improvising and playing with sounds, and when given a phrase of music, can complete a musical statement in a way that makes sense.
- May offer his or her own interpretation of what a composer is communicating through music. May also analyze and critique musical selections.
- May express interest in careers involving music such as being a singer, instrumentalist, sound engineer, producer, critic, instrument maker, teacher or conductor.
- May create original compositions and/or musical instruments.

Characteristics of Interpersonal Intelligence

- Bonds with parents and interacts with others.
- Forms and maintains social relationships.
- Recognizes and uses a variety of ways to relate to others.
- Perceives the feelings, thoughts, motivations, behaviors, and lifestyles of others.
- Participates in collaborative efforts and assumes various roles as appropriate from follower to leader in group endeavors.

- Influences the opinions or actions of others.
- Understands and communicates effectively in both verbal and nonverbal ways.
- Adapts behavior to different environments or groups and from feedback from others.
- Perceives diverse perspectives in any social or political issue.
- Develops skills in mediation, organizing others for a common cause, or working with others of diverse ages or backgrounds.
- Expresses an interest in interpersonally-oriented careers such as teaching, social work, counseling, management, or politics.
- Develops new social processes or models.

Characteristics of Intrapersonal Intelligence

- Is aware of his or her range of emotions.
- Finds approaches and outlets to express his or her feelings and thoughts.
- Develops an accurate model of self.
- Is motivated to identify and pursue goals.
- Establishes and lives by an ethical value system.
- Works independently.
- Is curious about the "big questions" in life: meaning, relevance, and purpose.
- Manages ongoing learning and personal growth.
- Attempts to seek out and understand inner experiences.
- Gains insights into the complexities of self and the human condition.
- Strives for self-actualization.
- Empowers others.

APPENDIX C

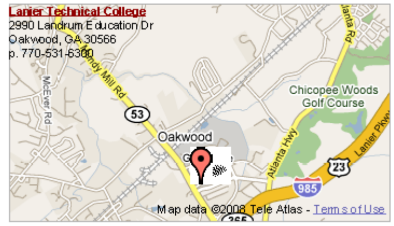
DEMOGRAPHICS OF LANIER TECHNICAL COLLEGE

Lanier Technical College

Request Info

General Information, Alumni, History, Campus, Students, Faculty, Address, Tuition, and Football

compare this school



Lanier Technical College School Images

Add an image ...

Information Summary

Ranks 1404th for total enrollment

Total Cost On-Campus Attendance	$2,186
Admission Success rate	N/A
Enrollment Total (all students)	3,196
Student Ratio Ratio of students to faculty	44 : 1

Demographics Main Campus and Surrounding Areas

Reported area around or near Oakwood, GA

Total Population	6,948 (6,912 urban / 36 rural)
Households	2,462 (2.81 people per house)
Families	1,877 (3.19 people per family)
Surrounding community	Small suburb (inside urban area but outside city, pop. under 100,000)
Pop. — African American	422
Pop. — Asian	170
Pop. — Pacific Islander	9
Pop. — American Indian / Alaskan Native	48
Pop. — White (incl. Hispanic)	5,758
Pop. — Other	641

Carnegie Foundation Classification

Associate's — Public Rural-serving Medium

Undergraduate	Associates
Graduate	N/A
Undergraduate Population	Higher part-time two-year
Enrollment	Exclusively undergraduate two-year
Size & Setting	Small two-year

General Characteristics

Highest offering	At least 2, but less than 4 academic yrs
Calendar System	Quarter
Years of college work required	N/A
Variable Tuition	✓

Student Tuition Costs and Fees

What are the typical tuition costs and fees for attending Lanier Technical College?

Ranks 3842nd for total cost of attendance

	In District	In State	Out of State
FT Undergraduate Tuition	$1,116	$1,116	$2,232
FT Undergraduate Required Fees	$270	$270	$270
PT Undergraduate per Credit Hour	$31	$31	$62
FT Graduate Tuition	N/A	N/A	N/A
FT Graduate Required Fees	N/A	N/A	N/A
PT Graduate per Credit Hour	N/A	N/A	N/A
Total Cost of attendance — On-Campus	$2,186	$2,186	$3,302
Total Cost of attendance — Off-Campus w/out Family	$13,522	$13,522	$14,638
Total Cost of attendance — Off-Campus with Family	$7,694	$7,694	$8,810

Student Tuition Cost History and Trends

Three year history and trends on the cost of attending

	In District	In State	Out of State
Published Tuition & Fees	$1,173 $1,386	$1,173 $1,386	$2,181 $2,502

	Cost (regardless of residency)	
Books & Supplies	$800	$800
On-Campus – Room & Board	N/A	N/A
On-Campus – Other Expenses	N/A	N/A
Off-Campus w/out Family – Room & Board	$9,828	$9,828
Off-Campus w/out Family – Other Expenses	$1,508	$1,508
Off-Campus with Family – Room & Board	$5,508	$5,508

Admission Criteria

What criteria does Lanier Technical College use for admissions?

Open Admissions	✓
Secondary School GPA / Rank / Record	N/A / N/A / N/A
College Prep. Completion	N/A
Recommendations	N/A
Formal competency demo	N/A
Admission test scores	N/A
TOEFL	N/A
Other tests	N/A

● = Required, ◒ = Recommended, ○ = Neither required nor recommended

Special Learning Opportunities

Distance Learning	✓
ROTC — Army / Navy / Airforce	✗ — ✗ / ✗ / ✗
Study Abroad	✗
Weekend College	✓
Teacher Certification	✗

Admission Credits Accepted

What types of credits does Lanier Technical College accept?

Dual Credit	✓
Life Experience	✗
Advanced Placement (AP)	✓

Student Services

Remedial Services	✓
Academic / Career Counseling	✓
PT Cost-defraying Employment	✓
Career Placement	✓
On-Campus Day Care	✗
Library Facility	✓

Student Living

First-time Room / Board Required	✗
Dorm Capacity	N/A
Meals per Week	N/A
Room Fee	N/A
Board Fee	N/A

Student Financial Aid Details

How many students use Financial Aid, and how much do they use?

	Average	Users	% of Attendees
Federal Grant Aid	$2,003	75	21%

State & Local Grant Aid	$1,166	338	93%
Institutional Grant Aid	N/A	N/A	0%
Student Loan Aid	N/A	N/A	0%
Any financial aid type		345	95%

Student Enrollment Demographics

How many students are enrolled at Lanier Technical College?

	Men	Women	Total
Non Resident Alien	N/A	N/A	N/A
Black Non-Hispanic	112	253	365
Hispanic	58	92	150
Asian / Pacific Islander	26	46	72
American Indian / Alaskan Native	N/A	8	8
White Non-Hispanic	955	1,629	2,584
Race Unknown	4	13	17
Total	1,155	2,041	3,196

Most Popular Fields of Study

The top 5 fields of study completed at Lanier Technical College.

	Men	Women	Total
Nurse/Nursing Assistant/Aide and P...	7	88	95
Emergency Medical Technology/Techn...	58	18	76
Medical/Clinical Assistant	N/A	70	70
Accounting Technology/Technician a...	5	55	60
Early Childhood Education and Teaching	1	58	59

Student Completion / Graduation Demographics

How many students are successful graduates?

	Non Resident Alien	Black Non-Hispanic	Hispanic	Asian / Pacific Islander	American Indian / Alaskan Native	White Non-Hispanic	Race Unknown	Total
Accounting Technology/Technician and Bookkeeping		4	5	6		45		60
Administrative Assistant and Secretarial Science, General		2	1	1		21		25
Allied Health Diagnostic, Intervention, and Treatment Professions, Other						6		6
Applied Horticulture/Horticulture Operations, General		1						1
Architectural Drafting and Architectural CAD/CADD		1				3		4
Autobody/Collision and Repair Technology/Technician		3	2			20		25
Automobile/Automotive Mechanics Technology/Technician		1	1	1		14		17
Banking and Financial Support Services						2		2
Business Administration, Management and Operations, Other						4		4
CAD/CADD Drafting and/or Design Technology/Technician			1			8		9
Child Care Provider/Assistant						4		4
Child Care and Support Services Management						2		2
Civil Engineering Technology/Technician						4		4
Clinical/Medical Laboratory Technician				2		2		4
Communications Systems Installation and Repair Technology		1						1
Computer Installation and Repair Technology/Technician						6		6
Computer Systems Networking and Telecommunications			1			39		40
Computer and Information Systems Security						5		5
Cosmetology/Cosmetologist, General		4	1	1		38		44
Criminal Justice/Safety Studies		4	3			36		43
Data Entry/Microcomputer Applications, General						16		16
Data Processing and Data Processing Technology/Technician		2	1	1		13		17
Dental Assisting/Assistant		1				12		13
Dental Hygiene/Hygienist						14		14

Drafting and Design Technology/Technician, General		1			25		26
Early Childhood Education and Teaching	8	2	1		48		59
Electrical/Electronics Equipment Installation and Repair, General					9		9
Emergency Medical Technology/Technician (EMT Paramedic)		1			74	1	76
Fire Science/Fire-fighting					5		5
General Office Occupations and Clerical Services	1	1			8		10
Graphic and Printing Equipment Operator, General Production			1		13		14
Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician (HAC, HACR, HVAC, HVACR)	1	1			8		10
Industrial Mechanics and Maintenance Technology	7				16		23
Legal Administrative Assistant/Secretary					1		1
Licensed Practical/Vocational Nurse Training (LPN, LVN, Cert	3	3	1		40		47
Machine Shop Technology/Assistant					30		30
Mechanic and Repair Technologies/Technicians, Other					1		1
Medical Administrative/Executive Assistant and Medical Secretary	1	1	1		6		9
Medical Insurance Coding Specialist/Coder	3				11		14
Medical Office Management/Administration			1		7		8
Medical Reception/Receptionist	6	1	1		19		27
Medical Transcription/Transcriptionist		1			6		7
Medical/Clinical Assistant	15	3	1		51		70
Nurse/Nursing Assistant/Aide and Patient Care Assistant	9	2	2	1	81		95
Operations Management and Supervision	3	1			32		36
Perioperative/Operating Room and Surgical Nurse/Nursing					1		1
Personal and Culinary Services, Other					1		1
Pharmacy Technician/Assistant		1	2		2		5
Phlebotomy/Phlebotomist	5	2	1		23		31
Prepress/Desktop Publishing and Digital Imaging Design					4		4
Sales, Distribution, and Marketing Operations, General			1		4		5
Security and Protective Services, Other							
Small Business Administration/Management	2				8		10
Surgical Technology/Technologist	3	2			6	1	12
Web Page, Digital/Multimedia and Information Resources Design					13		13
Welding Technology/Welder					12		12
Total	**91**	**39**	**25**	**1**	**879**	**2**	**1,037**

Faculty Compensation / Salaries

Lanier Technical College ranks 2990th for the average full-time faculty salary.

Tenure system	✓
Average FT Salary	$38,308 ($35,803 male / $39,997 female)
Number of FT Faculty	72 (29 male / 43 female)
Total Benefits	$650,455

Comment and Corrections

Familiar with this University? We would love to hear about your experience. Feel free to add comments or additional information regarding Lanier Technical College.

(State University.com, 2008)

APPENDIX D

MAT 1012 FOUNDATIONS OF MATHEMATICS STANDARD

Standard

☑ State Standard	☐ Institutionally Developed	College: N/A

MAT 1012 – Foundations of Mathematics

Course Description
Emphasizes the application of basic mathematical skills used in the solution of occupational and technical problems. Topics include: fractions, decimals, percents, ratios and proportions, measurement and conversion, formula manipulation, technical applications, and basic statistics.

Competency	After completing this section, the student will be able to:	Hours		
		Class	D.Lab	P.Lab/ O.B.I.

Competency Areas	Hours	
Fractions	Class	5
Decimals	D. Lab	0
Percents	P. Lab/O.B.I.	0
Ratios and Proportions	Credit	5
Measurement and Conversion		
Formula Manipulation		
Technical Applications		
Basic Statistics		

Prerequisite: MAT 097 or entrance arithmetic score in accordance with approved TCSG admission score levels.
Corequisite:

Course Guide

FRACTIONS		**6**	**0**	**0**
	Simplify fractions.			
	Multiply and divide fractions.			
	Add and subtract fractions.			
	Add, subtract, multiply, and divide mixed numbers.			
	Solve application problems with fractions.			
	Hierarchy of operations.			
DECIMALS		**5**	**0**	**0**
	Read and write decimal word names.			
	Identify place value.			
	Round decimal notation.			
	Add and subtract decimal notation.			
	Multiply decimal notation.			
	Divide decimal notation			
	Convert from fraction notation to decimal notation			
	Estimate with decimal notation.			
	Solve application problems with decimal notation.			
	Hierarchy of operations.			
PERCENTS		**6**	**0**	**0**
	Convert between percent and decimal notation.			
	Convert between percent and fraction notation.			
	Solve percent problems using percent equations.			
	Solve percent problems using proportions.			
	Solve application problems involving percents.			
RATIOS AND PROPORTIONS		**5**	**0**	**0**
	Define ratios and rates.			
	Simplify ratios in fraction form.			
	Find unit rates.			
	Define a proportion using cross products.			
	Solve application problems involving proportions.			
MEASUREMENT AND CONVERSION		**5**	**0**	**0**
	Convert linear measures involving American and metric units from one unit of measure to another.			
	Convert weight and mass units from one unit of measure to another.			

	Convert capacity from one unit of measure to another.			
	Solve application problems involving measurement and conversion.			
FORMULA MANIPULATION		**8**	**0**	**0**
	Solve basic formulas for a specified variable.			
	Identify basic two and three dimensional figures.			
	Find the areas of rectangular and circular figures.			
	Solve for volumes of cubes, rectangular solids, and right circular cylinders.			
	Identify, measure, and solve problems using angles.			
	Evaluate technical formulas.			
TECHNICAL APPLICATIONS		**10**	**0**	**0**
	Apply mathematical concepts of varied occupational applications.			
BASIC STATISTICS		**5**	**0**	**0**
	Solve applications involving circle, bar, and line graphs.			
	Solve applications involving frequency, distributions, and histograms.			
	Find the mean, weighted mean, median, and mode for a set of data.			

Suggested Resources

Media (text/audio/ visual/www/ other)	Author	Title: Subtitle	Edition	Place of Publication	Year	Publisher/Publication	pp.
Text	Akst, G. and Bragg, S.	*Basic Mathematics through Applications.*	*3rd Ed.*	Boston	(2005).	Pearson Education, Inc.	
Text	Lial, M., Salzman, S., and Hestwood, D	*Basic College Mathematics,*	*7th Ed.*	Boston	(2006).	Pearson Addison Wesley Longman.	

(Technical College System of Georgia, 2008b).

APPENDIX E

LANIER TECHNICAL COLLEGE PRESIDENT AUTHORIZATION LETTER TO CONDUCT RESEARCH

LANIER
TECHNICAL COLLEGE

Office of the President

November 17, 2008

TO WHOM IT MAY CONCERN:

Paul W. Godfrey is authorized to conduct research involving the established and commonly accepted educational settings of Lanier Technical College. Specifically, he is authorized to have all students taking a MAT 1012 Foundations of Mathematics class at Lanier Technical College during the fall quarter of 2008 and the winter and spring quarters of 2009 complete the READI assessment as part of their class. He is authorized to collect grade data on these students and the detailed results of their READI assessment. Both the completion of the mathematics course and the READI involve the normal educational practices of the College.

He is authorized to contact all Lanier Technical College mathematics instructors to gain their assistance in encouraging the students to complete the READI. He is authorized his normal access to Banner for data collection. He is also authorized the assistance of the GVTC coordinator in collecting and use of READI data.

The privacy of the students and staff will be protected and data collected will be handled in such a way that they remain anonymous. The data collection portion of this study should be complete by the end of FY2009.

Sincerely,

Michael D. Moye

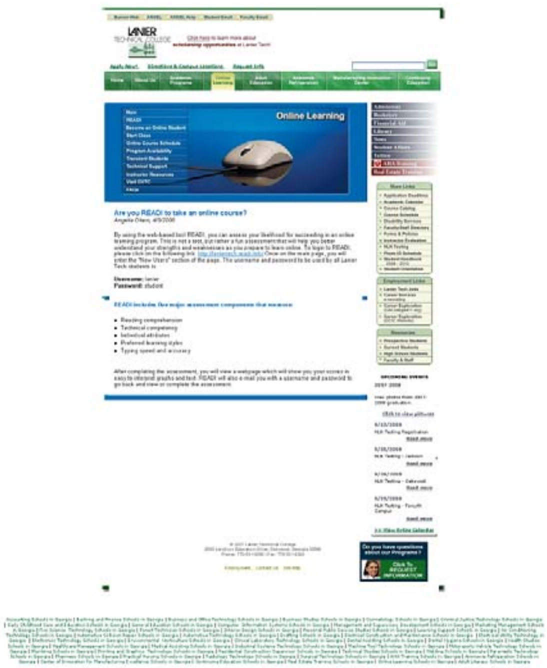
Michael D. Moye, Ed.D.
President

MDM:bs

APPENDIX F

READINESS FOR EDUCATION AT A DISTANCE INDICATOR (READI) ACCESS, READI INSTRUMENT, AND READI INDIVIDUAL REPORT

READI is a patent-pending tool provided by DECADE Consulting, LLC and may not be used in whole or in part without the expressed, written consent of DECADE Consulting LLC.



READI – Readiness for Education at a Distance Indicator

Are you ready to take an online course? By using the web-based tool READI, you can assess your likelihood for succeeding in an online learning program. This is not a test, but rather a fun assessment that will help you better understand your strengths and weaknesses as you prepare to learn online.

READI includes five major assessment components that measure:

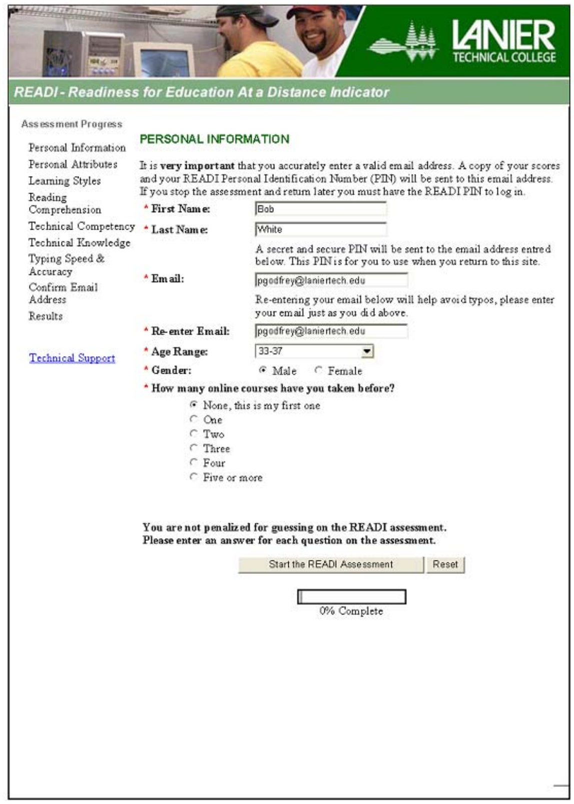
- Reading comprehension
- Technical competency
- Individual attributes
- Preferred learning styles
- Typing speed and accuracy

To login to READI, please click on the following link: **http://laniertech.readi.info/**

Once on the main page, you will enter the "New Users" section of the page. The username and password to be used by all Lanier Tech students is:

Username: **lanier**
Password: **student**

After completing the assessment, you will view a webpage which will show you your scores in easy to interpret graphs and text. READI will also e-mail you with a username and password to go back and view or complete the assessment.



READI - Readiness for Education At a Distance Indicator

Assessment Progress

- Personal Information
- Personal Attributes
- Learning Styles
- Reading Comprehension
- Technical Competency
- Technical Knowledge
- Typing Speed & Accuracy
- Confirm Email Address
- Results

I NEED TO STOP
click here for details

Technical Support

PERSONAL ATTRIBUTES

This section of READI measures items such as time management, procrastination, persistence, academic attributes, locus of control, and willingness to ask for help. There are no "right" or "wrong" answers. Indicate the answer choice which best describes how you really are, not how you may feel you should be or how you may feel the school would like for you to be.

Question	Not like me at all	Not much like me	Somewhat like me	Very much like me
1. I usually get things done without having to be directed by others.	○	○	○	○
2. I feel that if I set realistic goals, I can succeed no matter what.	○	○	○	○
3. Considering my personal and professional schedule, I can commit at least 6-9 hours per week to study for an online course. *Note: The amount of expected study time per course may vary significantly depending on the school and the specific course.*	○	○	○	○
4. I am likely to delay working on an assignment until it is almost due/near the deadline.	○	○	○	○
5. When I have an assignment or chore I don't like, I typically start working on that task and keep at it until it's done.	○	○	○	○
6. When I don't understand something, I am hesitant to ask the instructor for help.	○	○	○	○
7. I usually finish things I start.	○	○	○	○
8. Other than work-related activities, I can plan what I do and when I do it.	○	○	○	○
9. I have never dropped out of an academic program (high school or college).	○	○	○	○
10. I have already thought about how I will need to change my schedule to fit this course in.	○	○	○	○
11. I usually get things done ahead of time.	○	○	○	○
12. I am interested in taking online courses to earn a specific degree.	○	○	○	○

Question	Not like me at all	Not much like me	Somewhat like me	Very much like me
13. I am willing to spend significant time and energy to participate in an online course.	○	○	○	○
14. I need to have someone set deadlines for me to get things done.	○	○	○	○
15. I feel that change has a lot to do with being successful.	○	○	○	○
16. I like to figure things out on my own	○	○	○	○
17. I often have trouble getting things done on time.	○	○	○	○
18. I agree that school success is mostly a result of one's socio-economic background.	○	○	○	○
19. I have never failed to complete a course that I started.	○	○	○	○
20. I am concerned about being successful in this online program.	○	○	○	○
21. If faced with a problem I couldn't solve, I would ask the instructor for help.	○	○	○	○
22. I am able to express myself well in writing.	○	○	○	○
23. I am comfortable reading for more than 30 minutes at a time.	○	○	○	○
24. I think that intelligence is given and cannot be trained or become stunted.	○	○	○	○

Continue To Next Section | Reset

11% Complete

PATENT PENDING
READI Release 5.0

Privacy Information

READI - Readiness for Education At a Distance Indicator

Assessment Progress

- Personal Information
- Personal Attributes
- Learning Styles
- Reading Comprehension
- Technical Competency
- Technical Knowledge
- Typing Speed & Accuracy
- Confirm Email Address
- Results

I NEED TO STOP
click here for details

Technical Support

LEARNING STYLES

This section of READI measures your preferred learning style. People learn in different ways. Some like to learn alone, others prefer groups. Some like to listen to new information, some prefer reading new information. There is no "right" or "wrong" learning style. Indicate the answer choice which best describes how you really are, not how you may feel you should be or how you may feel the school would like for you to be.

the statement is very much like me
the statement is partially like me
the statement is nothing like me

1. You have a personal or private interest or hobby that you like to do alone.	○	○	○
2. You put together itineraries and agendas for travel. You put together detailed lists such as to-do lists.	○	○	○
3. Jingles, themes or parts of songs pop into your head at random.	○	○	○
4. You are happy in your own company. You like to do some things alone and away from others.	○	○	○
5. You like to read everything including books, newspapers, magazines, menus, signs, the milk carton, etc.	○	○	○
6. You navigate well and use maps with ease. You rarely get lost. You have a good sense of direction. You usually know which direction is North.	○	○	○

the statement is very much like me
the statement is partially like me
the statement is nothing like me

7. You prefer to study or work alone.	○	○	○
8. You like being a mentor or guide for others.	○	○	○
9. You keep a journal or personal diary to record your thoughts.	○	○	○
10. You communicate well with others and often act as a mediator between them.	○	○	○
11. You love sports and exercise.	○	○	○
12. You like to listen. People like to talk to you because they feel you understand them.	○	○	○
13. You like listening to music - in the car, studying, at work (if possible!).	○	○	○

the statement is very much like me
the statement is partially like me
the statement is nothing like me

14. You can balance a checkbook, and you like to set budgets and other numerical goals.	○	○	○
15. You use lots of hand gestures or other physical body language when communicating with others.	○	○	○
16. In school you enjoyed art, technical drawing, geometry.	○	○	○
17. You have a great vocabulary, and like using the right word at the right time.	○	○	○
18. You like the texture and feel of clothes, furniture and other objects.	○	○	○
19. You like text books with lots of diagrams or illustrations.	○	○	○
20. You easily express yourself, whether its verbal or written. You can give clear explanations to others.	○	○	○

the statement is very much like me
the statement is partially like me
the statement is nothing like me

21. You like playing games with others, such as cards and board games.	○	○	○
22. You use specific examples and references to support your points of view.	○	○	○
23. You can play a musical instrument or you can sing on (or close to) key.	○	○	○
24. You like crosswords, playing scrabble and word games.	○	○	○
25. You like logic games and brainteasers. You like chess and other strategy games.	○	○	○
26. You like getting out of the house and being with others at parties and other social events.	○	○	○
27. You enjoy dancing.	○	○	○

the statement is very much like me
the statement is partially like me
the statement is nothing like me

28. You don't like the sound of silence. You would prefer to have some background music or other noises over silence.	○	○	○
29. You draw well, and find your self drawing or doodling on a notepad when thinking.	○	○	○
30. You use diagrams and scribbles to communicate ideas and concepts. You love whiteboards (and color pens).	○	○	○
31. You easily absorb information through reading, audiocassettes or lectures. The actual words come back to you easily.	○	○	○
32. You like to understand how and why things work. You keep up to date with science and technology.	○	○	○
33. Music evokes strong emotions and images as you listen to it. Music is prominent in your recall of memories.	○	○	○
34. You think independently. You know how you think and you make up your own mind. You understand your own strengths and weaknesses.	○	○	○
35. You like gardening or working with your hands.	○	○	○

Continue To Next Section | Reset

22% Complete

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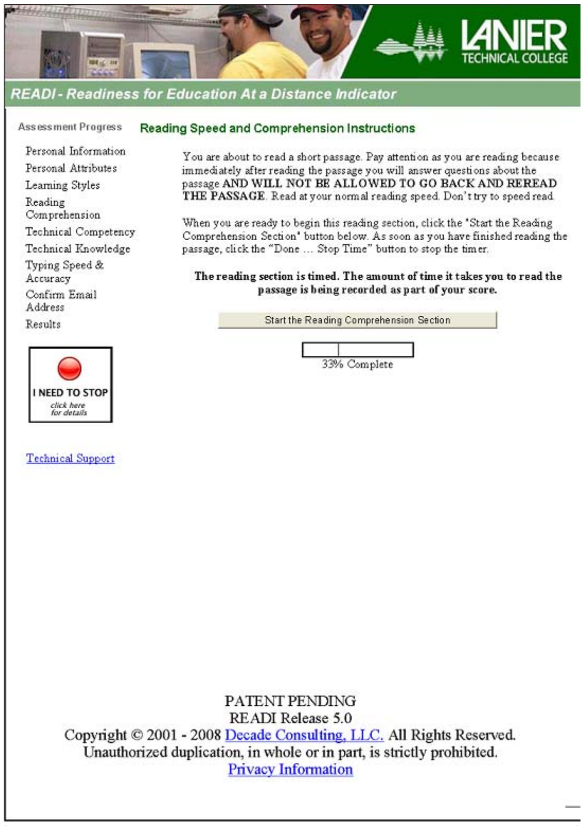


LANIER TECHNICAL COLLEGE

READI - Readiness for Education At a Distance Indicator

Assessment Progress

- Personal Information
- Personal Attributes
- Learning Styles
- Reading Comprehension
- Technical Competency
- Technical Knowledge
- Typing Speed & Accuracy
- Confirm Email Address
- Results

I NEED TO STOP
click here for details

Technical Support

Reading Speed and Comprehension Instructions

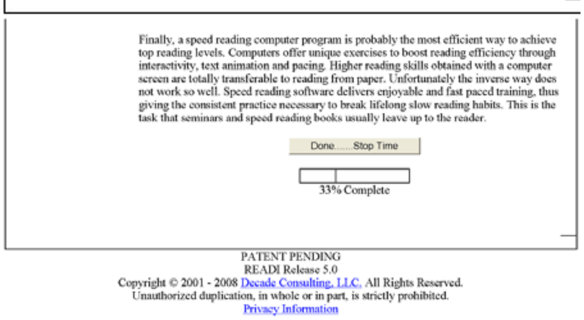
You are about to read a short passage. Pay attention as you are reading because immediately after reading the passage you will answer questions about the passage **AND WILL NOT BE ALLOWED TO GO BACK AND REREAD THE PASSAGE**. Read at your normal reading speed. Don't try to speed read.

When you are ready to begin this reading section, click the "Start the Reading Comprehension Section" button below. As soon as you have finished reading the passage, click the "Done … Stop Time" button to stop the timer.

The reading section is timed. The amount of time it takes you to read the passage is being recorded as part of your score.

Start the Reading Comprehension Section

33% Complete



Finally, a speed reading computer program is probably the most efficient way to achieve top reading levels. Computers offer unique exercises to boost reading efficiency through interactivity, text animation and pacing. Higher reading skills obtained with a computer screen are totally transferable to reading from paper. Unfortunately the inverse way does not work so well. Speed reading software delivers enjoyable and fast paced training, thus giving the consistent practice necessary to break lifelong slow reading habits. This is the task that seminars and speed reading books usually leave up to the reader.

Done……Stop Time

33% Complete

PATENT PENDING
READI Release 5.0
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Privacy Information

LANIER TECHNICAL COLLEGE

READI - Readiness for Education At a Distance Indicator

Assessment Progress

- Personal Information
- Personal Attributes
- Learning Styles
- Reading Comprehension
- Technical Competency
- Technical Knowledge
- Typing Speed & Accuracy
- Confirm Email Address
- Results

I NEED TO STOP
click here for details

Technical Support

Reading Speed and Comprehension

Reading is becoming more and more important in the new knowledge economy and remains the most effective human activity for transforming information into knowledge.

If top readers read at speeds of above 1000 words per minute (wpm) with near 85% comprehension, they only represent 1% of readers. Average readers are the majority and only reach around 200 wpm with a typical comprehension of 60%. This seems surprising since most readers, actively reading work documents, newspapers, magazines, books or the contents of a computer display are practicing daily for at least one hour. With such an intense training everyone should be close to top performances.

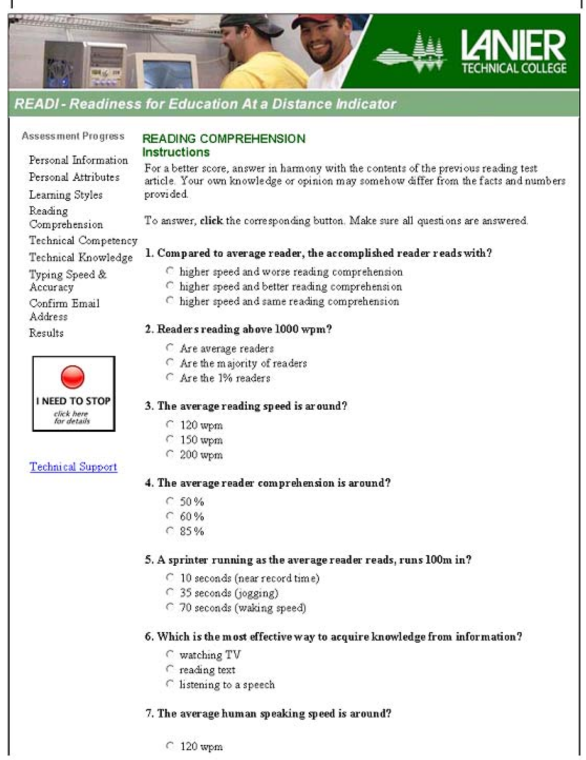
Unfortunately, this is far from the real situation. The average reader is five times slower than the good reader. Things are even worse if we consider reading efficiency as well as speed. Reading efficiency is reading speed weighted by comprehension rate and it amounts to 200 x 60% or 120 efficient words per minute (ewpm) for the average reader and to 1000 x 85% or 850 ewpm for top readers. Thus, an efficiency ratio of seven divides these two categories.

Compare the results of the average reader to other areas. We may imagine a sprinter practicing every day for several years on the running track and then just calmly walking for a race. We can also picture a racing driver never exceeding 30 mph or a pianist playing every day of the week for 20 years and only able to play music like a beginner. Unfortunately, since the age of 12, most readers do not substantially improve their efficiency and never reach their full capacity.

Every computer-user who is also a slow typist is aware of the benefits he could obtain with a typing course, but nearly no one suspects the much higher profits he could reach by improving his reading comprehension and speed. The rapid improvement of voice recognition may gradually make typing virtually obsolete since a good typist performs well under the speed of speech. On the other hand, human or computer speaking, with an average speed of 150 wpm, will always remain many times slower than a good reader, without any consideration of the skimming and skipping possibilities.

There are three possible ways to improve reading. The fastest is probably a speed reading seminar based upon good materials and animated by a dynamic instructor. It is quite usual for a slow reader to double and even triple his reading efficiency during a two-day class offering a positive atmosphere, carefully selected texts and comprehension tests. However, as this rapid and encouraging improvement is not sufficiently anchored, it often fades with time.

A book about speed reading is the second possibility. Such a book usually provides speed and comprehension tests as well as techniques to improve reading. It often includes more general information about concentration, interest stimulation, skimming techniques and ways to approach a text. Some methods may include audio or videocassettes. A book-based method requires a good deal of time as well as a strong commitment from the reader.



LANIER TECHNICAL COLLEGE

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Technical Support

READING COMPREHENSION
Instructions

For a better score, answer in harmony with the contents of the previous reading test article. Your own knowledge or opinion may somehow differ from the facts and numbers provided.

To answer, **click** the corresponding button. Make sure all questions are answered.

1. Compared to average reader, the accomplished reader reads with?

- higher speed and worse reading comprehension
- higher speed and better reading comprehension
- higher speed and same reading comprehension

2. Readers reading above 1000 wpm?

- Are average readers
- Are the majority of readers
- Are the 1% readers

3. The average reading speed is around?

- 120 wpm
- 150 wpm
- 200 wpm

4. The average reader comprehension is around?

- 50 %
- 60 %
- 85 %

5. A sprinter running as the average reader reads, runs 100m in?

- 10 seconds (near record time)
- 35 seconds (jogging)
- 70 seconds (waking speed)

6. Which is the most effective way to acquire knowledge from information?

- watching TV
- reading text
- listening to a speech

7. The average human speaking speed is around?

- 120 wpm

- 150 wpm
- 200 wpm

8. Most computer users want to?

- Improve typing
- Improve reading
- Buy a larger screen

9. What will lessen the importance of fast typing?

- Spelling-checkers
- More ergonomic keyboards
- Progress in voice recognition

10. A speed reading seminar or book lacks?

- Rapid results
- Consistent practice
- Deep enough explanations

11. What is probably the best way to reach top level reading efficiency?

- a speed reading book
- a speed reading seminar
- a speed reading software

Continue To Next Section | Reset

44% Complete

Match the task to the most appropriate application.

Spreadsheet	A. Write a letter
Word Processor	B. Manage a budget
Database	C. Track names and addresses

TASK 5 - Download and listen to an audio file

Often in online courses you will obtain information from audio files. Demonstrate your ability to download and play an audio file by clicking on the speakers below. In the audio file you will be given a secret word. After listening to the file insert the secret word into the box below.

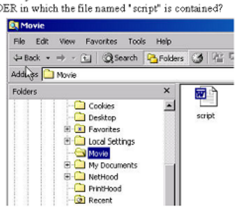
Click on these speakers to start downloading the audio file.

The secret word found in the audio file is

If you or your computer can not listen to/play audio files, please answer the alternative question.

TASK 6 - Identify files within folders

Often in online courses you will need to store and retrieve files within folders. What is the name of the FOLDER in which the file named "script" is contained?



The name of the FOLDER in which the file named "script" is located is:

TASK 7 - Identify an email attachment

Often in an online course an instructor may send you a document as an email attachment. In the image below what is the file name of the attachment?

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Technical Support

TECHNICAL COMPETENCY

In each of the following sections you will be given instructions to complete a specific task.

TASK 1 - Email Address

Identify which of the following is a correctly formatted email address.

- johndoeatyahoo.com
- johndoe@yahoo.com
- johndoe@yahoo
- http://www.yahoo.com

TASK 2 - Follow a link to find a secret word.

Follow the Internet link in the paragraph below to read more information about United States. If you successfully follow this link, you will find the secret word. Enter the secret word in the box below the paragraph to indicate that you successfully followed the link.

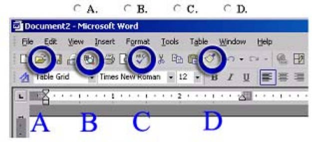
We the People of the United States in Order to form a more perfect Union, establish Justice, insure domestic Tranquility, provide for the common defense, promote the general Welfare, and secure the Blessings of Liberty to ourselves and our Posterity, do ordain and establish this Constitution for the United States of America.

The secret word is:

TASK 3 - Open a file

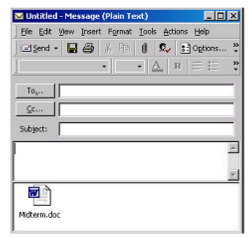
In an online course you are instructed to open a word processing file. Which area of the picture below should you click on to start the process of opening the word processing file?

- A.
- B.
- C.
- D.



TASK 4 - Identify the appropriate application

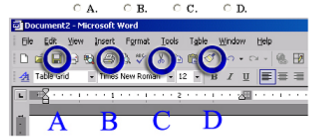
In an online course your instructor assigns you to design a fund raiser for a local school. As part of the assignment, you are to (1) write a letter about the fund raiser, (2) create a budget to track the income and expenses, and (3) track names and addresses of potential donors.



TASK 8 - Save a file

In an online course you are instructed to save a word processing file. Which area of the picture below should you click on to start the process of saving the word processing file?

- A.
- B.
- C.
- D.



TASK 9 - Print A file

Often in distance learning courses you will need to print a file. Which area of the picture below should you click on to start the process of printing this web site?

- A.
- B.
- C.
- D.

TASK 10 - Use a search engine

To find resources on the Internet for an online course you may need to use a search engine. The image below is taken from a search engine. Which area of the picture below should you click on to start the process of searching with this search engine?

- A.
- B.
- C.
- D.

Continue To Next Section | Reset

56% Complete

- I *have a system for regular backup of my data.* I could teach others how to save and organize their files.

(5) **Hardware/Troubleshooting**
- I *request help* when experiencing a problem with a computer.
- I can *disconnect computer cables, move the computer* and reconnect the cables so it will work.
- I can *identify and correct simple computer problems*; i.e. disconnected cables, printer jams, and frozen/ locked up computers. I understand the necessity and purpose and use of virus protection software.
- I can *successfully setup a new computer.* I can upgrade my computer's hardware components. I assist others with their hardware trouble-shooting.

(6) **Software Usage**
- I *do not use* a computer
- About all I know how to do on the computer is to surf the Internet, send and receive email, and/or play games.
- I can *run more than one program simultaneously* and have several windows open at the same time. I can install software and customize the look and sounds of my computer. I feel confident enough to teach others some basic operations.
- I can *trouble-shoot and successfully correct software problems.* I learn new programs on my own. I teach basic computer operations to others and help trouble-shoot other user's software problems

(7) **Internet**
- I *do not use* the Internet or do not have access to the Internet.
- I can *navigate the Internet to find relevant information.* I can use a variety of search engines to find relevant educational web sites and curriculum resources.
- I can *copy and paste text and graphics from a web site* and can edit my bookmark list. I can set my browser to a default home page of my choice. I know what cookies are.
- I can *download and install plug-ins and customize my preference settings.* I understand how to use memory caching to improve performance. I teach/support others to use advanced Internet skills and features.

Technology in your Life

(1) **How many of the following tasks have you done within the last 30 days?**
- Downloading music online • Banking Online
- Finding medical info online• Listening to the radio online
- Playing games online • Printing maps online
- Reading news online • Reserving travel arrangements online
- Shopping online • Using email

(2) **How many of the following devices do you own or use regularly?**
- Blackberry • Digital Camera
- Cell Phone • Digital Video Recorder
- DVD Player • GPS Device
- MP3 Player (iPod, ect.)• PDA - Personal Digital Assistant
- Scanner • Satellite Radio

Technology Vocabulary

in online courses.

(3) **What type of operating system do you have on the computer?**

(4) **How do you connect to the Internet?**

Continue To Next Section | Reset

67% Complete

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I NEED TO STOP
click here for details

Technical Support

TECHNICAL KNOWLEDGE

This section of READI measures your levels of knowledge about technology as well as levels of the usage of technology in your life. It also allows you to report some information about the primary computer you will use to take online courses.

Technology Usage

Select the description below which best describes your technology abilities and experience.

(1) **PDF Files**
- I *do not know what PDF files are.*
- I *am aware of what PDF files are* and my computer can download and view them.
- I regularly *view and can create* PDF files on my computer.
- I *can use advanced features* with PDF files such as adding digital signatures, password protecting, and integrating data fields.

(2) **Electronic Mail (eMail)**
- I *do not use* electronic mail (e-mail.)
- I *use e-mail and can read and send messages.* I can reply or delete received messages.
- I can *create groups of users, attach files, and manage/edit my address book.* I can subscribe to and unsubscribe from electronic mailing lists.
- I can use *advanced e-mail features such as filtering, delayed sending, and return receipts.* I teach/support others to use advanced e-mail skills and features.

(3) **Word Processing**
- I *do not use* a word processor.
- I can *create a new word processing document*, save, print, and then reopen the document later. My documents tend to use the same page setup, styles, and fonts.
- I can *change format (bold, italics), page orientation, and insert graphics into a word processing document. I can move text between documents. I use word processing for nearly all my professional work.*
- I can *create mail merge documents and use templates.* I use features such as tables, word art, and text boxes to enhance my document. I teach/support others advanced word processing skills and features.

(4) **File Management**
- I *do not save any documents* I create using the computer. I type and print. If I need to edit a document, I start over.
- I can *open and save documents on different drives.* I have not created any organized filing system and am not sure what a folder is.
- I *have a system for organizing my files and folders. I understand the importance of a regular backup of my data.*

Select the best definition for the following technology-related terms.

(1) **Asynchronous Communication**
- Online discussions occurring independent of time or location. Participants send messages to a central location (discussion forum) where they are archived for later retrieval from other participants.
- Online discussions occurring independent of location, but at the same time (real time). Participants must agree on a time to log into the discussion forum and messages are received at the moment they are sent.
- Communication programs that run in the background of a computer, enabling applications to run in real time.
- A mode of communication used to protect a networked server or client machine from damage by unauthorized users.

(2) **Blog**
- Stands for "Binary Logic Of Grammar." It is the syntax which governs the methodology used for creating computer software.
- The most common type of computer port used in today's computers.
- The bar that spans the bottom of the computer screen and contains the Start button on the left side and the systray and clock on the right.
- A Web site that contains dated entries in reverse chronological order (most recent first) about a particular topic. Functioning as an online newsletter, it can be written by one person or a group of contributors.

(3) **Browser**
- One who inspects something leisurely and casually.
- A computer program that is designed to replicate itself by copying itself into the other programs stored in a computer.
- A program that accesses and displays files and other data available on the Internet and other networks.
- Software designed to control the hardware of a specific data-processing system in order to allow users and application programs to make use of it.

(4) **Computer Virus**
- A long, rectangular image that can be placed just about anywhere on a Web page Most are 468 pixels wide by 60 pixels high (468x60). They may contain text, images, or sometimes those annoying animations that make it hard to focus on the page's content.
- A computer program that is designed to replicate itself by copying itself into the other programs stored in a computer. It may be benign or have a negative effect, such as causing a program to operate incorrectly or corrupting a computer's memory.
- A collection of pictures or images that can be imported into a document or another program.
- Text-based faces and objects that you often see in e-mail and online chat.

(5) **ISP**
- Stands for "Internet Security Practices." It is a set of guidelines for safely using the Internet.
- Stands for "Internet Service Provider." It is an organization that provides access to the Internet.
- Stands for "Installer Service Pack." This term defines the most recent version of upgrades for your computer.
- Stands for "Individual Service Policy." This is the agreement between a computer user and the company which manufactured the computer.

(6) **Emoticon**
- A quantity, defined by both magnitude and direction
- A software program that travels the Web locating and indexing websites for search engines
- Any external device that provides input and output for the computer.
- Keyboard characters used in combination to produce whimsical symbols representing a range of emotions.

(7) **Login**
- A compressed image file format
- An Internet-based discussion about a particular topic.
- A computer network limited to a small area such as an office building, university, or even a residential home.
- A combination of information that authenticates your identity. This could be a name and password or an ID number and security code.

(8) **Netiquette**
- Junk e-mail or irrelevant postings to a newsgroup or bulletin board
- Proper protocol for communicating on the Internet. It involves respecting others' privacy and not doing anything online that will annoy or frustrate other people.
- An internal or private network that can only be accessed within the confines of a company, university, or organization.
- Wireless technology used for short-range connections between desktop and laptop

(9) **Proctor**
- A clever or expert programmer who can gain unauthorized access to other computers
- A new user of a technology, such as a computer, a certain computer program, or the Internet
- The branch of medicine that deals with the diagnosis and treatment of disorders affecting the colon
- A supervisor of an examination from a school.

(10) **URL**
- Stands for "Upload Resolution Limiter." A software solution which controls the file size of images when they are uploaded into a web site.
- Stands for "Undergraduate Reference Librarian." This is the person in the library who assists students with using reference materials.
- Stands for "Ubiquitous Re-Locator." It is the process whereby Internet users are forwarded to the correct web site.
- Stands for "Uniform Resource Locator." It is the address of a specific Web site or file on the Internet. A URL cannot have spaces or certain other characters and uses forward slashes to denote different directories.

Personal Computer/Internet Specification

Answer the questions below about your **PRIMARY COMPUTER** - the one you will use most often to take your online courses.

(1) **Do you own a computer?**
- Yes
- No

(2) **Estimate how many years old the computer is which you will use to participate**

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I NEED TO STOP
click here for details

Technical Support

TYPING SPEED AND ACCURACY
Instructions

A student does not have to be an expert typist to succeed in an online course. However, the faster you can type and the fewer errors you make will impact your ability to participate in online courses.

Type the passage below at your normal typing pace in the box below. If you make a mistake you may correct it, but realize that this will lower your time. Immediately after you are finished typing, click the "Done" button. Click this button only once. There may be a slight delay as your individual score report is generated.

Use the choices below to indicate where you would like the original passage to be placed in relation to the text entry box.

Text to type here / You type the text here	You type the text here / Text to type here	Text to type here / You type the text here
Text to type is located on the left and the input box is located on the right.	Text to type is located on the right and the input box is located on the left.	Text to type is located above the input box.

Start Test

78% Complete

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TYPING SPEED AND ACCURACY
Instructions

Type the passage below at your normal typing pace in the box below. If you make a mistake you may correct it, but realize that this will lower your time. Immediately after you are finished typing, click the "Done" button. Click this button only once. There may be a slight delay as your individual score report is generated.

Probably the greatest benefit of online education is the incredible convenience that it offers. Unlike a traditional class, online courses usually do not have regular meetings. There still may be due dates for assignments and exams, and you may have scheduled chat sessions.

Done.......Stop Time

78% Complete

PATENT PENDING
READI Release 5.0

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Log Out

Technical Support

Congratulations!! Here are the results of your READI assessment. To **PRINT** these results click one of the two icons below. The Adobe Acrobat icon ( ) will open the results in the free Adobe Acrobat Reader. If you don't have Adobe Acrobat Reader installed on your machine, you can download and install it. Alternatively, you may click the Adobe Flash icon ( ) to view these results.

If you would like to **SAVE** these results to your local computer for future reference or to email to your instructor, click the Adobe Acrobat icon ( ). Then click the "Save" icon in the Adobe Acrobat Reader toolbar to save the file.

You can also use the PIN that has been sent to the email address you provided to log back in and review your results at any time.

Email this Report **Printing Options:**

A Guide to Interpretation of your READI Score

READI is a tool to help you assess your readiness for online learning. The **READI** tool is not intended to make an absolute decision as to whether or not you will succeed as an online learner. However, your scores will give you an idea of your strengths in the different components **READI** measures.

Student:	Bob White
School:	Lanier Technical College
Date of Assessment:	August 29, 2008
# of courses taken online:	0

Color Key

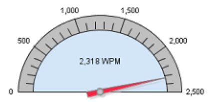
The color scale below is used throughout this score report to rate your results on each item.

Low High

RESULTS AT A GLANCE

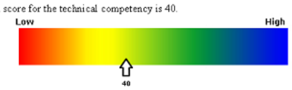
Your on screen reading comprehension was measured at 9 % as indicated below

Your on screen reading speed was measured at 2318 WPM as indicated below

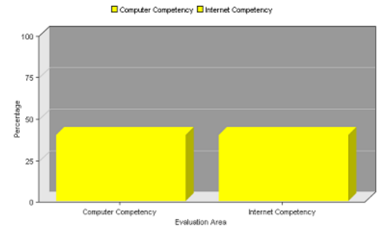


Technical Competency

Your overall score for the technical competency is 40.



In order to participate in class, a student must have some way to get to the classroom. A student in a traditional class may drive a car on a highway to attend class, but a student in an online course "drives" a computer on the Internet (the *Information Highway*) to "attend" class. Your score indicates that you may lack some of the basic skills needed to use a computer and the Internet. Research shows that students who are not comfortable using a computer and the Internet often fall behind in online courses. You may want to consider becoming more familiar with using personal computers and the Internet before you enroll in an online course.



Computer Competency = 40

Internet Competency = 40

Technical Knowledge

Your overall score for the technical knowledge is 18.

Technology Usage

Your current level of technology usage is a serious concern. In most online courses all course content and communications from the teacher and other students are provided using technology. It is strongly suggested that you seek the resources provided by your school for growth in this area. You may also use the Technology Tutorials provided below.

Technology in your Life

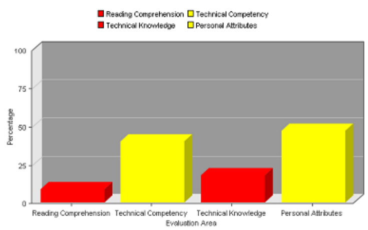
You are at the lowest level of technology usage on this scale. Persons who regularly use several items of technology and who regularly complete tasks online will have the experience needed to be comfortable and confident taking online courses. Because you are integrating very little technology into your regular routine it is recommended that you take advantage of the technology support services provided by your institution. You may also use the Technology Tutorials provided below.

Technology Vocabulary

You are at the lowest level of technology knowledge on this scale. In online courses some of the terms used on this assessment may be regularly used. You will be expected to know what the terms mean and how their meaning impacts your ability to learn. You are strongly encouraged to seek the technology support services provided by your institution to increase your understanding of technology. You may also use the Technology Tutorials provided below.

Personal Computer/Internet Specification

Do you own a computer?:
Your answer: Yes



COMPARISON TO NATIONAL AVERAGES

	Avg.	Percentile Bands
Overall Technical Competency	76	
-Computer Competency	79	
-Internet Competency	73	
Technical Knowledge	56	
Reading Competency	73	
Typing Speed	28	
Typing Accuracy	94	
		0 17 33 50 67 83 100

Key
National Average
Your Score

Reading Speed & Comprehension

The average adult reading speed for English prose text in the United States is around 250 to 300 words per minute. Research shows that reading is around 25% slower from a computer screen than from paper. Thus you may slightly increase your results to find your speed when reading from paper.

Comprehension	Your Comprehension	Reader Profile
50%	9%	Below average reader
60%		Average reader
80%		Good reader
85%		Excellent, accomplished reader

It is good that you own your own computer. You are encouraged to make sure that your virus protection is kept updated and that you regularly back up your files.

Estimate how many years old the computer is which you will use to participate in online courses.:
Your answer: 1 - 2

With a computer this new you should not have any problems accessing your online courses.

What type of operating system do you have on the computer?:
Your answer: Windows Vista, Windows XP Pro, Windows XP Home, Windows 2000

You should not have any problems accessing online courses with this operating system.

How do you connect to the Internet?:
Your answer: Network

You should not experience problems connecting to your online courses using a network connection. However, check with your Information Technology department to see if any firewalls exist which could be problematic.

Personal Attributes

This section measures six items: time management, procrastination, persistence, academic attributes, locus of control, and willingness to ask for help. These attributes can be enhanced or improved through academic interventions. Ask your faculty member or academic advisor about the resources for remediation and/or support which your school may provide.

The maximum possible score for this section is 96. You scored a total of 45. Your results are below.

Academic Attributes

Academic attributes reflect your history of success with academic pursuits as well as your perceived ability to perform well academically. **Your score indicates that you may experience academic challenges.** It is recommended that you discuss this with someone such as an academic advisor or faculty member.

Help Seeking

The Help Seeking category reflects your willingness to ask for help when you encounter a problem. It is very important in an online course that when you are confused about the course content or the online course process that you seek help from the faculty member or other appropriate person. **Your score indicates that you resist asking for help.** When you experience problems in online courses, do not waste time, seek help soon.

Persistence

Persistence is a measure of your likelihood to finish what you started. **Your score indicates a low rate of persistence based on your prior experience.** It is recommended that you seek the support of your faculty member, fellow students, family or others to encourage you to remain active in the course. During an online course you may have feelings of isolation or feel overwhelmed. At these times don't allow yourself to become discouraged and entertain ideas of dropping out. Hang in there!

Procrastination

Procrastination is putting off till tomorrow what could be done today. Because you may not face your teacher and fellow students each week, it is easy to delay starting work on assignments. **Your score indicates that you are somewhat likely to procrastinate.** You are encouraged to get started immediately on course assignments. Imagine how good it would feel to complete an assignment early.

Time Management

Most online courses do not require any class attendance. However, a significant amount of time is still required each week for reading course materials. **Your score indicates that time management is a challenge for you.** It is recommended that you carefully read the course syllabus, then get a calendar and plan the due dates for all of your assignments. Plan for a specific number of hours each week to work on course assignments.

Locus of Control

Locus of Control is a measure of the degree to which you feel that you are in control of what happens to you. A person with high (internal) locus of control believes that their experiences are controlled by their own skill or efforts. **Your score indicates a high degree of locus of control.** This attribute will serve you well since many online courses require the student to take much initiative in the learning process.

Preferred Learning Styles

Learning style is an individual's unique approach to learning based on strengths, weaknesses, and preferences. Everyone has a mix of learning styles. Some people may find that they have a dominant style of learning, with far less use of the other styles. Others may find that they use different styles in different circumstances. There is no right mix. Nor are your styles fixed. You can develop ability in less dominant styles, as well as further develop styles that you already use well. By recognizing and understanding your own learning styles, you can use techniques better suited to you. This improves the speed and quality of your learning.

View your Learning Styles graph above to identify your dominant style(s). Once you have located your dominant style(s), you may click on the book icons below to learn more about each style. To close the information on each style, simply click the book icon again.

The learning styles are:

Visual (spatial) - You prefer using pictures, images, and spatial understanding

Aural (auditory-musical) - You prefer using sound and music

Verbal (linguistic) - You prefer using words, both in speech and writing

Physical (kinesthetic) - You prefer using your body, hands and sense of touch

Logical (mathematical) - You prefer using logic, reasoning and systems

Social (interpersonal) - You prefer to learn in groups or with other people

Solitary (intrapersonal) - You prefer to work alone and use self-study

If you'd like to learn about how to use learning styles as part of an overall accelerated learning program, visit the Memletics Accelerated Learning Manual's home page.

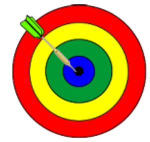
For more information on learning styles visit the Memletics website.

Typing Proficiency

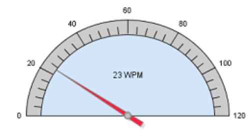
A student does not have to be an expert typist to succeed in an online course. However, the faster you can type and the fewer errors you make will impact your ability to participate in online courses.

The average workplace typist reaches about 50 to 60 words per minute. The average web surfer comes in at around 30 words per minute, at a peak. Many online courses require you to type as you participate in discussion boards, email the instructor, and compose papers. If you type slower than about 20 words per minute, you should consider using a resource such as www.learn2type.com. This resource is the leading FREE Web site that helps you master the skills of touch typing. Whether you're a typing expert or just a "hunt & peck" beginner, the interactive exercises in this Typing Tutor automatically adjust to your skill level. The better you get, the more challenging the Typing exercises become. You can come and go as you please and pick up the typing lesson where you left off.

Gross Score:	24 WPM
Total Errors:	2
Net Score:	23 WPM
Time Elapsed:	1 minute 43 seconds
Characters Per Minute:	155
Accuracy:	95.2%
Text Given:	Probably the greatest benefit of online education is the incredible convenience that it offers. Unlike a traditional class, online courses usually do not have regular meetings. There still may be due dates for assignments and exams, and you may have scheduled chat sessions.
Text Typed:	Probably the greatest of online education is the incredible convenience that it offers. Unlike a traditional class, online courses usually do not have regular meetings. There may still be due dates for assignments and exams, and you may have scheduled chat sessions.
Errors Found:	Probably the greatest benefit of online education is the incredible convenience that it offers. Unlike a traditional class, online courses usually do not have regular meetings. There still may be due dates for assignments and exams, and you may have scheduled chat sessions.



Your accuracy was measured at 95.2%



Average Typing Speeds

1 Top 10%	64 - 120 WPM	
2nd 10%	56 - 63 WPM	
3rd 10%	49 - 55 WPM	
4th 10%	44 - 48 WPM	
5th 10%	38 - 43 WPM	
6th 10%	34 - 37 WPM	
7th 10%	30 - 33 WPM	
8th 10%	26 - 29 WPM	
9th 10%	21 - 25 WPM	<<< Your Score
Bottom 10%	4 - 20 WPM	

Support List of Helpful Tips

From: Dr. Mac Adkins [macadkins@decadeconsulting.com]
Sent: Wednesday, September 03, 2008 9:55 AM
To: 'Paul Godfrey'
Subject: RE: Use of READI in Research

Paul,

Yes, it will be fine for you to include the items which READI measures. However please provide the following disclaimer. READI is a patent-pending tool provided by DECADE Consulting, LLC and may not be used in whole or in part without the expressed, written consent of DECADE Consulting, LLC. Good luck.

Mac

APPENDIX G

INSTITUTIONAL REVIEW BOARD APPROVAL

From: Kim Fowler [kfowler@uga.edu]	
Sent:	Tuesday, January 13, 2009 11:07 AM
To:	rbhill@uga.edu
Cc:	pgodfrey@uga.edu
Subject:	IRB Approval - Hill
Attachments:	consent letter (informational letter) to obtain informed consent REVISED.doc

PROJECT NUMBER: 2009-10448-0
TITLE OF STUDY: Characteristics of successful and unsucessful technical college students in online and face-to-face mathematics classes
PRINCIPAL INVESTIGATOR: Dr. Roger B. Hill

Dear Dr. Hill,

The University of Georgia Institutional Review Board (IRB) has approved the above-titled human subjects proposal that was reviewed by expedited review procedure. You may now begin this study. Your approval packet will be sent by mail.

Note: I made minor corrections to the Consent Letter to include language currently recommended by the IRB. An e-copy is attached to this email; please save this revised document for any future continuing review/amendment requests and for use with your participants. Thanks.

Please remember that no change to this research proposal can be initiated without prior review and approval by the IRB (except when necessary to eliminate apparent immediate hazards to the research participant). Any adverse events or unanticipated problems must be reported to the IRB immediately. The principal investigator is also responsible for maintaining all applicable protocol records (regardless of media type) for at least three (3) years after completion of the study (i.e., copy of approved protocol, raw data, amendments, correspondence, and other pertinent documents). You are requested to notify the Human Subjects Office if your study is completed or terminated.

Good luck with this study, and please feel free to contact us if you have any questions. Please use the IRB project number and title in all communications regarding this study

Thank you,

Kim Fowler
Human Subjects Office
606A Boyd Graduate Studies Research Center
University of Georgia
Athens, GA 30602-7411
kfowler@uga.edu
Telephone: 706-542-5318
Fax: 706-542-3360
https://www.ovpr.uga.edu/compliance/hso/

(Opt-out statement to be emailed to all MAT 1012 students through the ANGEL course portal used for all classes AFTER grades have been submitted each quarter)

Dear MAT 1012 student:

I hope you got a lot out of the MAT 1012 Foundations of Mathematics course and the READI evaluation you completed at the beginning of the course. In order to determine how to better meet the needs of the students, I am doing research on the preferred learning styles, technical competencies, on-screen reading speed and comprehension, and typing speed and accuracy as determined by the READI evaluation and the success students have in the class.

This study, entitled Characteristics of Successful and Unsuccessful Technical College Students in Online and Face-to-Face Mathematics Classes, seeks to find out differences and/or similarities in preferred learning styles, technical competencies, on-screen reading speed and comprehension, and typing speed and accuracy of technical college students in this basic mathematics class. I will use the READI data you provided as part of your participation in the basic mathematics course MAT 1012 and the course grades recorded in the BANNER student database system. You don't have to do anything else. Of course, I remove all names and identifying information from data before I use them in this research.

If you do not want your data to be used in my research on this type of class project, please mark the box below, print your name, sign, and return the form to me via email (pgodfrey@laniertech.edu) FAX (770-531-6328) or on paper (Paul Godfrey, 2990 Landrum Education Drive, Oakwood, Georgia 30566). Please contact me with any questions about this project.

Since your grade in this course has already been recorded, you can be assured that neither your grade nor anything else related to this class will be affected by your willingness or unwillingness to have your paper included. Your participation is voluntary and you can refuse to participate or withdraw at any time without penalty or loss of benefits to which you are otherwise entitled. Do NOT sign the form or return it if you ARE willing to have your data used in this research.

You may change your mind at any time and decide later that you do not want to have your paper used. If you do this, simply sign and return the form, and I will remove any data I can identify as coming from you from any research I am doing. If you have any questions or concerns about your rights as a research participant, please contact The Chairperson, Institutional Review Board, University of Georgia, 612 Boyd GSRC, Athens, GA 30602-7411; telephone (706) 542-3199; email address irb@uga.edu.

O I do NOT want my READI data or grades used in this research.

Printed Name________________________________

Quarter MAT 1012 was taken ___________________

Signature of Participant ________________________

Date ____