STUDENTS’ MOTIVATION TO LEARN: AN EVALUATION OF PERCEPTIONS, PEDAGOGY, AND DESIGN IN ONE E-LEARNING ENVIRONMENT

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A dissertation submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Education in the School of Education.

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The purpose of this initial study was to investigate secondary students’ motivation to learn, mathematics attitudes, and perceptions of transactional distance and social presence as a framework for evaluating virtual high school online learning. The investigation began with a sample of size of 41 virtual high school students enrolled in a web-based Algebra I course that was taught by one teacher in an urban virtual high school. The dropout rate was high, which resulted in only 10 students participating in the study. The students’ attitudes and perceptions were evaluated in light of their learner profiles and mathematics achievement in the course. Nine of the 10 students were considered in the study as academically at-risk. The students’ ages ranged from 14 to 16 years, and they were enrolled in either 9th or 10th grade. Several students were repeating the course for recovery credits.

Due to the small number of participants, this study offers only descriptive statistics and qualitative data what support strictly preliminary and speculative interpretations. Given this stipulation, this study may illuminate some potential relationships between the participants’ attitudes and their academic performance. The students who passed the course appeared to possess positive mathematics attitudes,
higher motivation, and lower perceptions of transactional distance than the students who failed the course. Social presence did not appear to be different between passing and failing students. Future studies should include larger sample sizes in multiple virtual school settings over a greater period of time so to shed greater light on the relationships of the virtual high school students’ attitudes and perceptions to their academic achievement and learner profiles.

As part of this study, a framework for evaluating e-learning high school mathematics courses was developed. This framework served as the foundation to develop and evaluation tool used in the study, the *e-Learning Evaluation Tool for Algebra I Courses* (e-LETAC). The evaluation of the course suggested that the design and pedagogy was in need of improvement. However, the e-LETAC did not include a concise rubric. In future studies, this tool should be expanded to include a solid and reliable rubric.
DEDICATION

“The purpose of life is not to be happy. It is to be useful, to be honorable, to be compassionate, to have it make some difference that you have lived and lived well.”

Ralph Waldo Emerson

To my dearest friend, Piper Weckerly.

You always told me: Don’t sweat the small stuff!
Piper, you were always on my shoulders, whispering this mantra.
I know you are in a wonderful place.
Peace be with you.

To my husband and best friend, George.

I don’t know why you put up with me, but I am so fortunate to have you in my life.
You did the shopping. You made dinner. You vacuumed and did the laundry. You picked me off the floor and let me use your shoulder. You checked my numbers. And most of all, you un-split my infinitives! This dissertation is as much yours as it is mine.
Your support and love keeps me going!
I love you for life and beyond!

To my daughter, Jaana.

I can’t even imagine my life without your wonderfully exasperating temperament providing me with comic relief. I am so proud of who you have become. Your loyalty and dedication is something I aspire to match. You have supported my professional life even when it has taken me away from you over the years.
I love you so very much!
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The students and the teacher who told their stories to me. You were brave souls and I wish you the best of life. To all of you, young and old, stay in school!

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CHAPTER I
INTRODUCTION

e-Learning—“it’s being called a quiet revolution, but school leaders are listening.” (Rivero, 2005, p. 40)

Fueled by the need to accommodate both non-traditional and disadvantaged students and to provide courses not otherwise available in the local district, the K-12 market began to embrace e-learning in the mid-1990s (Litke, 1998; Moore & Kearsley, 1996; Zucker & Kozma, 2003). In a survey of use of e-learning (Watson & Ryan, 2006), 24 states reported they had statewide e-learning programs, and nearly every state reported at least one secondary cyber school and/or a district-sponsored online program. As defined by Clark (2001), virtual schools, often referred to as cyber schools, are “educational organizations that offer K-12\(^1\) courses through the Internet or web-based methods” (p. 1). The explosion in the use of virtual schools (U.S. Department of Education, 2004) begs the question why. Why is there such a rapid movement to implement e-learning programs at the K-12 level?

When surveyed by the U.S. Department of Education (Setzer & Lewis, 2005), districts reported numerous reasons why they support e-learning courses for their

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\(^1\) The use of K-12 when discussing virtual schools is an industry standard and will be used in this study where there is a discussion of virtual schools and students in general. However, to date, there are only 8 state virtual schools that offer elementary level virtual courses and 14 states that offer middle school courses. One state (North Dakota) offers virtual courses to students in grades as low as 4th grade. There are private schools who also offer K-8 virtual courses.
students. The specific reasons were often tied to the size, location, or demographics of the district surveyed (Setzer & Lewis, 2005). For example, urban school districts list a variety of reasons that motivate the use of e-learning, including the ability to:

1. Provide access to advanced placement and enrichment courses not otherwise available within the district curriculum,

2. Allow failing students to repeat coursework,

3. Allow ill or disabled students to work from home,

4. Provide an alternative for students who do not perform well within a traditional classroom setting, and

5. Accommodate a growing student population despite limited space within the brick-and-mortar high schools (Flaxman, Schwartz, Weiler, & Lahey, 1998; Setzer & Lewis, 2005).

In addition, districts are under pressure to meet the requirements of the No Child Left Behind Act (NCLB) signed by President Bush on January 8, 2002. With the passing of the NCLB, many districts across the nation face the possibility of failing to meet the requirements of this legislation (Kleiman, 2004). NCLB requires every school to have highly qualified teachers for all students and to guarantee that all students achieve a proficient level of education. This legislation is proving to be a challenge for urban districts. For example, urban districts have difficulty in recruiting and retaining the highly qualified teachers required by NCLB, especially for advanced and enrichment courses (Haberman, 2004; Lewis, Ceperich, & Jepson, 2002). Teacher salaries in these districts are often not competitive (Snipes, Doolittle, & Herlihy, 2002), and the teacher turnover rate is higher than the national average (Harrington-Lueker, 1999; Kleiman, 2004).

Implementing or participating in e-learning programs provides one possible alternative for school districts, including urban districts, to meet the academic needs of
their students and the requirements of NCLB (Kleiman, 2004). e-Learning programs offer students nationwide access to courses and highly qualified teachers not otherwise available in the local school districts (Berman & Tinker, 1997). In addition, some of the benefits of many e-learning programs include:

1. Allowing students to study from any place at their own pace (Shepherd, 2003)
2. Compensating for problematic scheduling conflicts (e.g., when the schedule of two courses overlap) (Watson, 2005), and
3. Adapting the learning environment and curriculum for students at-risk (Chaplin, 2001; Harrington-Leuker, 1999; Hassel & Terrell, 2004; Rivero, 2005)

The potential for these programs to provide highly qualified teachers teaching advanced, enrichment, and recovery courses to students worldwide is immense (Berman & Tinker, 1997). This claim is further evidenced by the inclusion of e-learning as one of the seven primary recommendations made by the National Education Technology Plan for states, districts and schools (U.S. Department of Education, 2004).

**Background of the Study**

Although there is a wealth of research confirming the effectiveness of e-learning at the tertiary level (Bernard et al., 2004), the question of whether the use of e-learning programs is an effective alternative in teaching our high school population is still under-researched (Blomeyer, 2002; Cavanaugh, 1999; Smith, Clark, & Blomeyer, 2005). Clark (1983) reported that the media used to deliver instruction did not influence learning, and he recommended that research focus not on the media but on the instruction. In partial agreement with Clark, Kozma (1991) proposed that research should focus on the learner actively collaborating with the medium as a means to construct knowledge. Yet, early studies of educational technology in the traditional classroom, K-12, focused primarily on
In recent years, calls for “rethinking the research agenda” (Perraton, 2000, p. 1) have been made in an attempt to focus on theoretical principles underlying the use of technology for the delivery of instruction (Benbunan-Fich, Hiltz, & Harasim, 2005; Franklin & Bolick, 2005; Garrison, 2000). “Practice-based research can be likened to the branches of a tree…Theoretical principles can be likened to the roots: it is the root system that determines the health of the tree and also the extent to which it can grow” (Nichols, 2003 as cited in Benbunan-Fich et al., 2005, p. 19). In response to this call, researchers (Allan, 2004; Berge, 2002; Chen, 2001b; Dutton, Dutton, & Perry, 2002; Jiang & Ting, 2000; Picciano, 2002) have focused on the application of existing learning theories and pedagogical approaches in e-learning environments with adult learners. However, the younger e-learner may have a different reaction to an e-learning environment (Smith et al., 2005), and there is little, if any, research on how high school students learn within such an environment. The National Educational Technology Plan (U.S. Department of Education, 2004) recommends that all students, at all levels, be provided with supplemental or full course access to e-learning. Thus, this recommendation “provides an ideal opportunity for articulating a plan for meaningful research” (Roblyer & Knezek, 2003, p. 60) for the K-12 arena.

This study focuses specifically on one component of what is likely to be a rather broad research agenda. It is important to gain a better understanding of the high school student’s experience of e-learning. Such an understanding needs to take into account the nature of the learning environment as it specifically relates to issues connected with
learning at a distance. These issues may vary from one subject to another, as well. An e-
learning Algebra I course is used as the backdrop for this study. Algebra I is a
prerequisite for graduation in 20 states and the District of Columbia (Achieve, 2004). It is
offered in 8th or 9th grade in most school districts. Algebra I is also the gateway into
higher mathematics courses, such as Geometry, Algebra II, and Calculus (Achieve, 2004;
ACT, 2004; Cavanaugh, Gillan, Bosnick, & Hess, 2006). For these reasons, enrollment in
Algebra I is typically large and represents a greater diversity in the student body than
higher level mathematics courses.

“Whether students are going on to a two- or four-year college or directly into the
workplace, taking challenging mathematics in high school is the gatekeeper that either
opens or shuts the door to opportunity (Achieve.org, n.d. ¶ 2).” Thus, it is important that
the learning experience in Algebra I, whether in a face-to-face or an e-learning
environment, be positive and successful for the student. Students who are not successful
are unlikely to take the higher mathematics courses that will prepare them for college or
today’s workforce. As reported by Cavanaugh et al. (2006), researchers (see Beatty,
2005; McCoy, 2005; Gamoran & Hannigan, 2000) have explored the effective instruction
within face-to-face algebra courses. One study (Cavanaugh et al., 2006) compared the
effectiveness of an online algebra course at the Florida Virtual School with a traditional
classroom-based algebra course within the Florida public schools. The results of that
study were less than compelling since only 12 out of the 139 virtual students qualified to
take the assessment exam at the end of the study, as compared with the 97 out of 98

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2 The format of this citation follows APA guidelines and represents the website and the paragraph number for the quote.
traditional students who took the assessment. That study did not attempt to determine what factors that led specifically to the success or failure of the virtual algebra students.

**Significance of the Study**

Due to the exponential growth of K-12 e-learning programs (Clark, 2001; Clark, 2004; Hadderman, 2002), research on these programs has lagged behind implementation. This is particularly so in relation to the pedagogy underlying virtual high school course offerings (Smith et al., 2005). Research is required to understand virtual high school students’ motivation to learn, their attitudes towards mathematics, and their perceptions of transactional distance, and social presence in an e-learning environment. In addition, a full evaluation of the course design and the identification of the pedagogical practices students’ perceive as improving or hindering quality instruction may help stakeholders and developers identify course adaptations that will provide students with the best possible e-learning experience in virtual high schools. As these effects may differ between rural, suburban, and urban students, and between different content areas, this study only addresses students enrolled in an urban virtual high school Algebra I course.

**Purpose of the Study**

The purpose of this study is to investigate secondary students’ motivation to learn, mathematics attitudes, and perceptions of transactional distance and social presence in an Algebra I course offered in an urban virtual high school. The purpose includes an investigation into what instructional practices students perceive as improving instruction, as well as a full evaluation of the course design, including its pedagogy, in light of current e-learning and mathematics best practices.
Research Questions

I. Are the motivations to learn, mathematics attitudes, and perceptions of transactional distance and social presence of secondary students enrolled in a virtual high school Algebra I course in an e-learning environment related to their respective learner profiles and mathematics achievement?

II. How might the design, including the pedagogical practices, of a secondary virtual e-learning Algebra I course be described in light of existing principles of best practice in mathematics and a virtual learning high school environment?

III. What specific pedagogical practices are perceived by secondary students enrolled in a virtual high school Algebra I course in an e-learning environment as contributing to their motivation to learn, mathematics attitudes, and perceptions of transactional distance and social presence?

Overview of the Chapters

Chapter Two provides an historical perspective to set this study in context. The chapter begins with an overview of the trends in urban education and then provides a history of e-learning and virtual high schools.

Chapter Three outlines the theoretical framework for this study and provides a literature review of the four constructs: motivation to learn, mathematics attitudes, transactional distance, and social presence.

Chapter Four provides a background discussion of reformed-based mathematics focused on high school algebra instruction, instructional systems design, and best practices and course design in a virtual high school environment. Each of these areas
were blended to systematically develop a model or tool, the *e-Learning Evaluation Tool for Algebra I Courses*, that was implemented to evaluate the e-learning Algebra I course within this study.

Chapter Five details the methodology in this study. The chapter outlines the mixed-methods research design used, including the rationale behind this approach, a description of the research site and participants, and the analytical procedures used to evaluate the data. A brief review of the *e-Learning Evaluation Tool for Algebra I Courses* will be provided, along with a description of how this tool was used to evaluate the course design and pedagogy.

Chapter Six discusses the analysis and results, and answers the research questions. The results are based on a mixed-methods approach that provides insight into how students perceived their e-learning Algebra I experience in terms of the theoretical constructs outlined and what the relationship of this experience was to their learner profiles and mathematics achievement. In addition, the results of the evaluation of the course design and pedagogy is reported.

Chapter Seven summarizes the study and discusses the implications for stakeholders involved with providing e-learning opportunities for Algebra I students. The chapter also discusses the limitations of the study, as well as providing recommendations for further research.

**Definition of Terms**

For the purpose of this dissertation the following terms are defined.

**Computer-Assisted Instruction (CAI):** Any time, any place instruction delivered with the assistance of a computer so that the student may proceed at her own pace. Examples
of CAI software include: drill-and-practice; tutorial; simulation; educational games; problem solving; applications.

**Distance Education**: "Distance Education is instructional delivery that does not constrain the student to be physically present in the same location as the instructor. Historically, Distance Education meant correspondence study. Today, audio, video, and computer technologies are more common delivery modes" (Steiner, 1995).

**e-Learning** (electronic learning): “Term covering a wide set of applications and processes, such as web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivery of content via Internet, intranet/extranet (LAN/WAN), audio and videotapes, satellite broadcast, interactive TV, CD-ROM, and more” (Watkins, 2005, p. 17). E-Learning is a form of distance education.

**Face-to-Face (F2F)**: Traditional classrooms or schools where students meet in the same physical location as their teacher and fellow classmates. Also referred to as brick-and-mortar classrooms or schools.

**Math Anxiety**: A general level of discomfort that results in a lack of confidence, increased frustration, reduced satisfaction, and a feeling of helplessness towards mathematics (Ma, 1999).

**Minority**: For the purpose of this study, the term minority or minorities refers to African-American, Hispanic, and Latino.

**Motivation**: An individual’s desire to learn course content.

**Relationship**: In statistics, a relationship suggests that two variables may be interconnected in some way, but there may not be a cause and effect between the variables. In the results section of this study the words “related” and “relationship” may
be used but nothing statistically significant is claimed. The terms are used simply to suggest that a pattern or trend may exist between two or more variables. As stated in Creswell (2005), such “conclusions do not establish a probable cause-and-effect relationship” (p. 327).

**Social Presence**: The degree that an individual is perceived as a “real person in mediated communication” (Gunawardena, 1995, p. 151).

**Transactional Distance**: The cognitive space perceived to exist among learning peers, teachers and content.

**Urban School Districts**: An urban school district is defined as a district that has been assigned a locale code of 1 (large city) by the U.S. Census Bureau (2000) and the National Center for Educational Statistics’ Common Core of Data (2005a).

**Virtual High Schools**: “A state approved and/or regionally accredited school that offers secondary courses through distance learning methods that include Internet-based delivery” (Clark, 2001, p.1). The researcher proposes that this definition should be updated to include any e-learning delivery method.

**Virtual Schools**: As defined by Clark (2001) virtual schools are “educational organizations that offer K-12 courses through the Internet or web-based methods” (p. 1). Virtual schools may also offer other forms of e-learning opportunities.
CHAPTER II
E-LEARNING

Introduction

This chapter provides grounding in the evolution and research about e-learning from its beginnings in higher education to its infusion into the K-12 learning environment. The history of distance education evolving from the 19th century correspondence courses to present day e-learning is described. Major research meta-analyses that shed light on what we know about impact of distance education and where we should direct future research are discussed.

The History

Throughout the history, advances in technology have powered paradigmatic shifts in education. E-Learning, as a form of distance education, has triggered a significant paradigm shift in the way education is dispensed. To understand the impact of e-learning on K-12 education, it is helpful to understand from where this phenomenon grew and why.

Learning from a distance is not a new phenomenon in our society. Distance education is instructional delivery that does not require the student to be physically present in the same location as the instructor or other classmates (Steiner, 1995). Correspondence courses have been offered to students since the 19th century (Cavanaugh, 2004; Fulton, 2002a; Moore & Kearsley, 1996). Isaac Pitman, the English inventor of shorthand, is recognized as the first person to implement correspondence
courses in 1840, in Bath, England, to teach shorthand to adult students to transcribe Bible passages (Moore & Kearsley, 1996). Anna Ticknor in 1873 established in Boston the Society to Encourage Study at Home, a network of women teaching women via correspondence. Coined as the silent university, the society provided personalized instruction in English, history, science, French, German, and art to more than 7,000 women, irregardless of status or geographical location, at a time when women were not afforded the same educational opportunities as men (Bergmann, 2001; Larreamendy-Joerns & Leinhardt, 2006). In the 1880s, William Harper, a seminary teacher and the first president of the University of Chicago, taught Hebrew via correspondence from the Chautauqua University to adults (McIsaac & Gunawardena, 1996; Moore & Kearsley, 1996). At the same time, Thomas Foster taught mine safety via home study; his work eventually grew into the creation of the International Correspondence School (Geary, 2003; Jefferies, 2005).

While correspondence courses exist even today, in the 20th century, much of distance education efforts moved to delivery through instructional radio and television (Moore & Kearsley, 1996). With the advent of satellite technology, distance education moved using satellite TV and then cable TV in the 1970s and 1980s (Jefferies, 2005). By the 1980s, implementation of distance education programs in higher education became a routine phenomenon (Moore & Kearsley, 1996). The popularity of distance education grew with the introduction of the World Wide Web in the early 1990s. This popularity evolved from the demand of non-traditional students for access to a college education without the necessity of having to attend a brick-and-mortar institution (Jones, 2002).
These adult learners are often balancing jobs, family obligations or other obligations that interfere with their ability to attend traditional university classes (Hiltz & Shea, 2005).

In the past few years, distance education has become ubiquitous in higher education (Kriger, 2001; National Education Association, 2000). The National Center for Educational Statistics (NCES, 2002) surveyed 1,599 randomly selected 4-year and 2-year higher education institutions to provide national estimates on distance education in higher education. In the 12-month period between 2001 and 2002, NCES estimates that there 82% of 2.8 million enrollments in distance education courses were undergraduates.

Survey data reported by 2,251 degree-granting higher education institutions indicated that 3.2 million tertiary-level students took at least one online course during the fall of 2005 (Allen & Seaman, 2006).

Figure 2.1 provides a picture of the distribution of these students based on their level of study. From this same survey, 56.1% of the Chief Academic Officers reported the learning outcomes of online instruction to be the same or better than for face-to-face instruction.

![Figure 2.1: Level Of Students Taking At Least One Online Course in fall 2005 (Adapted From Allen and Seaman, 2006, p.5)](image-url)
K-12 courses have been offered through distance education as early as 1906 with paper/pen correspondence. In 1906, Virgil Hilyer of the Calvert School in Baltimore began offering correspondence courses to elementary school children who were unable to attend the Calvert Day School (Calvert School, n.d ¶ 2). This school celebrated its 100th year in existence in 2006.

![An Academic Alternative](Calvert School, n.d. ¶ 1)

K-12 distance courses moved to TV programming as the primary media in the 1960’s (Cavanaugh, 2004; Fulton, 2002a; Moore & Kearsley, 1996). In a 1994 bipartisan effort, Congress and the Clinton/Gore administration initiated the building of the information superhighway, digitally linking the Internet, CATV, telephone, business, entertainment, information providers, and educators. With this initiative the road to virtual K-12 programs grew rapidly during the mid-1990s specifically to address the
equity issues facing our school districts (Litke, 1998; Zucker & Kozma, 2003). This movement into the K-12 classroom has major implications for education at all levels. Distance education may be the resolution to our growing student enrollment, our overcrowded schools, and teacher shortages (Bipartisan Congressional Web-based Commission, 2002).

K-12 distance education is primarily a rural and urban phenomenon. These areas have different problems that motivate its use. This study is interested in the use of distance education in urban areas. Urban districts contend with poor student retention rates, low graduation rates, high failure rates, and an increasing population of at-risk students living in poverty who do not demonstrate strong reasoning and problem solving skills (Geary, 2003; Haberman, 1991). The minority rate is high in urban school districts with African-Americans representing 33% of the student population and Hispanic students representing 24% (Loveless, 2003).

There is a growing gap in funding between districts serving primarily white students and districts that serve mostly minority students (Education Trust, 2004). A similar gap is also exits between high-poverty and low-poverty school districts (Carey, 2004). Such a funding gap contributes to the urban district’s inability to provide quality education to its students (Jones & Sandidge, 1997). The teacher attrition rate is higher in urban districts. The national average for teacher attrition is approximately a third of new teachers within the first three years and half within the first five years (Chapman, 2005; Smith & Smith, 2006). Teacher turnover in urban schools is twice the national average (Haberman & Rickards, 1990; Ingersoll, 2002; Kleiman, 2004; Mont & Rees, 1996; Ng, 2003). With high attrition rates, urban schools do not have a stable teaching staff and
often must rely on under-qualified teachers or inexperienced teachers to instruct the nation’s highest proportion of at-risk students (Education Trust, 2004; Jones & Sandidge, 1997; Smith & Smith, 2006).

On January 8, 2002, President George W. Bush signed into law the No Child Left Behind Act of 2001 (NCLB), a law that greatly expands the federal role in public education. Under this law, states are required to increase student testing, collect and disseminate subgroup results, ensure a highly qualified teacher in every classroom, and guarantee that all students, regardless of socioeconomic factors, achieve a "proficient" level of education by the 2014-2015 school year. NCLB defines the highly qualified teacher as one who has full state certification or has passed a state’s teacher licensing exam(s) and holds a valid state teacher’s license. Additionally, the highly qualified teacher must hold a minimum of a bachelor’s degree and demonstrate competency in the subjects she teaches (Kleiman, 2004; National Education Association, 2004).

With the passage of the NCLB, urban districts face the possibility of failing to meet the requirements of this legislation. Although the intention of the legislation is to improve teacher quality, the reality is that urban school districts may have great difficulty in meeting the requirements of the NCLB legislation since urban districts already have a hard time recruiting and retaining qualified teachers. NCLB complicates an already challenging situation for urban school districts (Feistritzer, 1999; Kleiman, 2004; McDonnell, 2005; National Education Association, 2004; Salinas, Kritsonis, Herrington, 2006).

A lawsuit filed by the ACLU against the State of California (Daniel v. California, 1999) exemplifies the issues in providing educational opportunities and highly qualified
teachers for all of our students, as required by NCLB. In July of 1999, before NCLB, the American Civil Liberties Union (ACLU) filed a class-action lawsuit on behalf of four students at Inglewood High School, an urban school in Los Angeles County, because the school only offered three AP courses (ACLU, 2003). The school’s student body is 97% African-American and Latino. In the neighboring city of Beverly Hills, the high school offered 14 AP courses. Although Beverly Hills is also an urban community, unlike Inglewood, the Beverly Hill’s population is very wealthy, and the high school has only 8.8% African-American and Latino students (ACLU, 2003).

Table 2.1: Percent of minority students vs. Number of AP courses offered: Beverly Hills vs. Inglewood, Ca

<table>
<thead>
<tr>
<th></th>
<th>Beverly Hills</th>
<th>Inglewood</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Minority Students</td>
<td>8.8%</td>
<td>97%</td>
</tr>
<tr>
<td># of AP courses offered</td>
<td>14</td>
<td>3</td>
</tr>
</tbody>
</table>

The ACLU accused the State of California of denying low-income and minority students equal access to education. The case created sufficient pressure and attention to compel the enactment of legislation creating the California’s Advanced Placement Challenge Grant Program, which provides for four-year grants of up to $30,000 each to 550 California high schools to use for AP course development (ACLU, 2003). The Daniel case is particularly compelling since it very specifically brings these equity issues to the forefront.

Like California, states and school districts across the nation are looking for solutions to the availability of highly qualified teachers and the inability to offer the courses students require to have a competitive and equitable education. One solution is
the implementation of e-learning in school districts. The terms online school, cyber school, net school, and virtual schools are often used interchangeably (Fulton, 2002a). Virtual schools are defined as any educational organization that provides K-12 courses from a distance through some form of e-learning (Clark, 2001). What is e-learning? The term is an abbreviation for the term electronic learning, a form of distance education.

   e-Learning (electronic learning): Term covering a wide set of applications and processes, such as web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivery of content via Internet, intranet/extranet (LAN/WAN), audio and videotapes, satellite broadcast, interactive TV, CD-ROM, and more. (Watkins, 2005, p. 17)

   e-Learning is “being called a quiet revolution, but school leaders are listening” (Rivero, 2005, p. 40). Michigan state legislators listened. They recently passed a “pioneering proposal” (eSchool News, 2006 ¶ 1) that made Michigan the first state in the U.S. to mandate by law that all students complete least one online course or online experience³ as a requirement for graduation (Michigan Virtual University, 2006).

   Michigan’s K-12 system has stepped into the 21st Century by fully recognizing the value of teaching and learning in a virtual environment. The importance of requiring all students to take an online course today can be compared to the efforts to teach young people how to use print resources in a public library 50 years ago. (Michael Flanagan, Michigan’s State Superintendent of Public Instruction, Michigan Virtual University, 2006)

This legislation is just another step in the virtual schooling movement for Michigan. The Michigan Virtual High School, established in 1999, is one of the largest in the nation (e-School News, 2006; Watkins, 2005).

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³ To meet the online experience requirement the student’s school district or public school academy must have integrated an online experience throughout the high school curriculum by requiring that each teacher of a course that provides a required credit to graduate has integrated an online experience into the course.
Michigan is not the only state to support the growing number of students enrolling in e-learning courses. There were 14 states with virtual high schools in operation in 2000-2001, with approximately 40,000-50,000 students enrolled (Clark, 2001). Nineteen states had public online schools in 2002 (Hadderman, 2002). During the 2002-03 school year, approximately 36% of public school districts had students, at some level, enrolled in e-learning courses. In 2002-03, 68% of all K-12 students enrolled in e-learning courses across the country were high school students (Setzer & Lewis, 2005).

Statewide and cyber school programs report double-digit increases in registrations and enrollments (Watson, 2005). Districts report that the primary reasons they supported e-learning courses for their students include the ability to:

- Offer courses to their students not otherwise available through the district,
- Offer AP and college-level courses,
- Address a growing student population and limited space,
- Reduce scheduling conflicts for students,
- Permit a failing student the opportunity to retake a course,
- Meet the needs of specific groups of students, and
- Generate more district revenues (Setzer & Lewis, 2005).

As of September 2006, there are 24 states (see Figure 2.3) with state-led online education programs, which are defined as an online learning program that were created by legislation or by a state-level agency and administered by the state education agency (Watson & Ryan, 2006). Some of these programs include upper elementary and middle school courses. To date, there are 8 state virtual schools that offer elementary level virtual
courses and 14 states that offer middle school courses. One state (North Dakota) offers virtual courses to students in grades as low as 4th grade.

The purpose of the virtual high school classroom is to reach students who do not have equal access to high school coursework or who cannot attend a traditional high school for any number of reasons, including physical and mental disabilities. Some school districts are also attempting to use virtual high schools to reach out to students who simply do not tolerate the physical classroom environment and thus drop out of school.

Figure 2.3: States with a state-led K-12 online education program (adapted from Watson & Ryan, 2006)

e-Learning may be delivered synchronously, asynchronously, or as a combination of the two. There are multiple technologies that support synchronous interaction, such as chat rooms, instant messaging, videoconferencing, and computer-assisted conferencing. These technologies allow the instructor and students to be separated by distance but not by time. For example, the North Carolina School of Science and Mathematics (NCSSM) offers advanced courses to rural North Carolina high school students using synchronous
interactive videoconferencing over the North Carolina Information Highway and the Internet (Haught & Stern, 2006). Interactive videoconferencing is a real-time communication tool that allows the teacher and students to participate in live instruction and discussions (Heath, Holznagel, deFord, & Dimock, 2002). Additional technologies may be used at the discretion of the instructor when deemed appropriate to enhance the instruction.

Asynchronous e-learning does not use simultaneous interaction between the instructor and the students. Asynchronous delivery includes email, listservs, audiocassette courses, videotaped (VCR or DVD) courses, online computer-based learning programs, and web-based courses. Instruction and learning are considerably more flexible in an asynchronous environment, thus allowing a student to choose when and where she will gather the instructional materials and contribute to discussions or ask questions.

Wake County (North Carolina) Public School System’s (WPCSS) program illustrates the use of a private provider for online computer-based learning (Harlow & Baenen, 2002). The district served 114,000 K-12 students in 2003-2004, with approximately 30% minority student population (National Center for Education Statistics, 2005b; Wake County Public School System Annual Report, 2004). WCPSS began a 3-year program in 1997 to coordinate efforts to serve at-risk high school students in its school system. Seventeen strategies were implemented. Strategy #17 was the introduction of NovaNet, an online computer-based learning program offered by Pearson Digital Learning, to 17 high school labs and 2 alternative middle schools (Faircloth & O'Sullivan; 2001).
According to Pearson Digital Learning (n.d.), NovaNet offers a basic skills curriculum for both the at-risk student and the student wishing to accelerate his academic program. The program is housed in school computer labs, often designated specifically for NovaNet. The program presents instructional material for the students to read and then the program provides online tests to assess comprehension. Students progress through the material at their own pace, with the program advancing as students correctly answer the assessment questions. Although participating schools must have a lab coordinator, there is no online instructor interacting with the students.

The program was implemented in WCPSS in an attempt to reduce dropout rates and provide an alternative for credit recovery for students who needed to get back on track for graduation. Faircloth & O’Sullivan (2001) reported that 73.8% of attempted course credits were completed successfully and 843 students recovered enough credits to be back on track for graduation over the three years of the program.

Web-based instruction, another form of asynchronous instruction, is often delivered through course management software (CMS), such as WebCT or Blackboard. Both WebCT and Blackboard provide an e-learning, asynchronous classroom that offers course design and navigation, asynchronous discussion forums, document sharing, grade books, quiz/survey functions, live chat rooms, and e-mail management (WebCT, n.d.). For example, the Virtual High School (VHS), headquartered in Hudson, Massachusetts, offers web-based high school courses through a consortium of other schools (Bethea, 2002; Virtual High School, n.d.a; Zucker et al., 2003). As of 2000, 84% of the VHS high school students were college preparatory, 17% were economically disadvantaged, 20% were minority students, and 3% were identified as limited English proficient (Zucker et
The Virtual High School offers advanced courses, as well as technical and school-to-work courses using Blackboard. The courses use “scheduled asynchronous”\(^4\) and online with no face-to-face interaction between the teacher and the students (Zucker et al., 2003). During the 2003-2004 the school enrolled 5,059 students, taking any one of 154 courses (Virtual High School, n.d.c).

As of 2007, the consortium consisted of 457 member schools representing 28 participating states and 35 different countries. Each member school is required to contribute faculty and site facilitators for at least one course, and in return the schools are allowed to enroll a proportional number of students in VHS courses. The VHS reports an enrollment of 9,111 middle and high school students in 241 courses, which includes middle school enrichment courses at the end of the 2006-2007 school year (Virtual High School, n.d.a).

**The Research**

Institutions at all educational levels paint a positive picture of their online learning programs. How reliable are these pictures? Although the number of students engaged in online learning is based on actual enrollment figures, the success of online course learning outcomes over those of face-to-face courses may represent impressions only, rather than fact. So the question is what does the research say about the effectiveness of distance learning?

\(^4\)“Schedule asynchronous” is a termed used by some in the field to refer to asynchronous courses that have assignment deadlines.
Higher Education

Executing a query in ERIC for all documents using the qualifiers (a) higher education, (b) distance education, and (c) e-learning reveals 9,980 hits (as of November 10, 2006). Clearly the research about distance education in tertiary institutions is overwhelming. Important meta-analyses (Bernard, Abrami, Lou, & Borokhovski, 2004; Phipps & Merisotis, 1999; Russell, 1999) exist that have examined large numbers of research studies in this area. Thomas Russell’s (1999) meta-analysis is recognized as providing a major contribution to the field of distance education. Russell’s meta-analysis of 355 research studies, reports, and dissertations, dating back as far as 1928, supports findings of no significant difference in student outcomes based on the form of instructional delivery, such as face-to-face versus at a distance (Russell, 1999). The included studies used a variety of means for determining student outcomes, including:

- Satisfaction surveys,
- Grade comparisons,
- Standardized test scores, and
- Participant interaction statistics.

This meta-analysis primarily included media comparison studies (MCS) rather than pedagogical or theoretical studies. The analysis paints the picture that no matter the medium used to deliver instruction at a distance, there is nothing that specifically inherent in the choice of the medium that improves learning. What improves learning is the redesigning of a course to adapt the content to the technology (Russell, 2001). Caution is warranted when considering the no significant difference conclusion, since many of the included studies cross-referenced each other or cited the same or similar research, and
many of the studies were not the original research (Phipps & Merisotis, 1999). The Russell analysis inflates the number of studies that support the no significant difference conclusion.

The Phipps and Merisotis (1999) meta-analysis examined 40 studies published since 1990 considered to be the “most important and salient” (p.11) original research, which used descriptive research, case studies, correlation research, and experimental design. Most of the selected studies concluded that there was no significant difference between distance learning and face-to-face instruction. However, several shortcomings existed in the selected research that makes this conclusion suspect. These shortcomings included the lack of

- Control for extraneous variables, such as teacher instructional differences, so cause and effect cannot be assured,
- Randomly selected subjects,
- Adequately validated and reliable measurement instruments, and
- Control for the perceptions and attitudes of the subjects.

These shortcomings exist in much of the literature and tend to cloud the conclusions that can be drawn from the research (Anglin & Morrison, 2000; Bernard et al., 2004; Perraton, 2000; Saba, 2000, Ungerleider & Burns, 2003).

Bernard et al. (2004) selected and evaluated 232 out of 2,262 studies published between 1985 and 2002 for their analysis. Studies prior to 1985 were not included because the researchers focused on distance education that was electronically mediated and interactive, which primarily did not begin until after 1985. The inclusion criteria assured that all studies had (a) measurable outcomes that were the same or comparable, (b) original data, (c) experimental and control groups within an individual course rather
than an entire program, and (d) identified levels of the learners. The researchers specifically focused on three outcomes of the included research studies: achievement, attitudes, and retention. The results of this meta-analysis might suggest large variability for all three outcomes. Due to this large variability, caution should be taken to not generalize the data to the entire population. Table 2.2 summarizes the major conclusions drawn by the researchers from the studies included in this meta-analysis.

When synchronous and asynchronous instruction is combined in the course design, increased achievement over face-to-face instruction was inconsistent and was found to be dependent upon the circumstances. When comparing achievement in synchronous, asynchronous, and face-to-face instruction, face-to-face instruction outperformed synchronous instruction, but asynchronous instruction outperformed both face-to-face and synchronous instruction. Attitude favored the traditional classroom over synchronous instruction, but there was no significant difference between asynchronous and face-to-face instruction. Retention comparisons also favored the traditional classroom in comparison to either distance education formats. However, a lower dropout rate was associated with synchronous instruction than with asynchronous instruction. One might speculate that the higher dropout rate of asynchronous instruction may be due to the similarity of synchronous instruction to the traditional classroom so that the students may have a greater sense of group membership and social pressure to remain in the synchronous DE class (Bernard et al., 2004). Areas of mathematics, science, and engineering appeared to be best suited to the traditional classroom, while subjects related to computing and military/business were better suited for distance education.
Methodology and pedagogy were found to be more important than the media used to achieve success in all distance education outcomes.

Table 2.2: Conclusions from Bernard et al. (2004) meta-analysis

<table>
<thead>
<tr>
<th>Course Design</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Achievement</strong></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>When synchronous and asynchronous instruction was combined in the course design, increased achievement over face-to-face instruction was inconsistent and was found to be dependent upon the circumstances.</td>
</tr>
<tr>
<td>Synchronous</td>
<td>Traditional instruction outperforms synchronous DE.</td>
</tr>
<tr>
<td>Asynchronous</td>
<td>Asynchronous DE outperforms traditional instruction and Synchronous DE.</td>
</tr>
<tr>
<td><strong>Attitudes</strong></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>Overall, attitudes towards DE were less positive than towards traditional instruction.</td>
</tr>
<tr>
<td>Synchronous</td>
<td>Preferential attitudes toward the traditional classroom were significant.</td>
</tr>
<tr>
<td>Asynchronous</td>
<td>Effect size of asynchronous DE was not significant.</td>
</tr>
<tr>
<td><strong>Retention</strong></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>Overall, student dropout rate is lower in the traditional classroom.</td>
</tr>
<tr>
<td>Synchronous</td>
<td>Dropout rate is higher for asynchronous DE than for synchronous DE.</td>
</tr>
</tbody>
</table>

As did the Russell (1999) meta-analysis, this meta-analysis suggests that it is the course design, including the pedagogy, not the media that is important in achieving learner outcomes. The media are “vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition” (Clark, 1983, p. 445). Overall, course design influences achievement and attitude more than the choice of medium. Appropriate course design is crucial to all
forms of instruction, including and perhaps especially distance education, since there is
the separation of teacher and student that needs to be overcome.

It is important to interpret the results of each of these meta-analyses with caution.
Russell’s findings lack rigorous selection criteria. Specifically, his analysis does not
account for the differences in the quality of each study’s research methodology which
may affect each study’s conclusions. Russell’s analysis represents more of an annotated
bibliography of studies supporting the no significant difference phenomenon, rather than
a full analysis of each study that compares distance education to face-to-face instruction.
Phipps and Merisotis (1999) work may be biased as it also does not include clear
selection criteria to determine the quality of each study’s methodology and conclusions.
Bernard et al. (2004) includes extensive criteria for study selection, one being that
rigorous statistical analysis be a part of each study in the review. However, the variability
among the studies reviewed suggests that caution should be exercised when drawing any
definitive conclusions from the data. It should also be noted that each of these analyses
failed to include rich qualitative studies that often shed light on the gray areas within a
statistical study.

K-12 Education

There is a body of literature (i.e., Augustine-Shaw, 2001; Cavanaugh, 2004;
Clark, 2001; Seltzer & Lewis, 2005; Smith, 2001; Watson, 2005; Watson & Ryan, 2006;
Zucker & Kozma, 2003) that provides a comprehensive view of the trends,
implementation, and issues in the development of virtual schools. However, there is a
much smaller body of literature that addresses the effectiveness of distance education on
the academic achievement of the K-12 student. Three meta-analyses provide a summary of the current research on four forms of distance education within virtual schools; (1) satellite TV, (2) online telecommunications, (3) two-way videoconferencing, and (4) web-based instruction (see Table 2.3).

Barker (1992) analyzed three early studies (Hobbs & Osburn, 1988; Pease & Kitchen, 1987; Pease & Tinley, 1987) about the effectiveness of satellite TV instruction. The results of these studies were consistent; academic achievement as a result of satellite TV instruction was as good as or better than face-to-face instruction. One study, Hobbs and Osburn (1988), reported on both administrator and student satisfaction with satellite TV instruction. The researchers reported that 46% of the students indicated that they felt they had learned an acceptable amount of content and the remainder indicating they did not learn enough. The researcher’s suggested that the students’ satisfaction most likely related to their interaction with the delivery system and their academic success through their attendance in the satellite TV programs. However, the principals expressed satisfaction due to extraneous factors such as cost and implementation considerations and the ability to provide instruction to students who would otherwise have no access to specific instruction missing from their home school or district. Consequently, administrators may pressure course designers to get the content to the students as quickly as possible, which often results in overlooking the appropriate pedagogy that is very important to the student’s academic achievement and satisfaction.

It is important to note that Barker (1992) reported on only three studies and none of these studies, specifically addressed pedagogy or made a serious attempt to qualitatively understand the specific goals of the research participants to determine the
origin of their level of satisfaction. Satisfaction is a difficult emotion to quantify without
the inclusion of qualitative data that bring the nuances to the forefront.

Interactive distance education includes, but is not limited to, online
telecommunications (e.g., email and the Web) and two-way videoconferencing. Online
telecommunications are specifically designed to supplement and support traditional
classroom instruction, smaller groups, and shorter learning experiences. In contrast, two-
way videoconferencing is used for longer durations and larger student groups.

Cavanaugh (2001) analyzed 19 experimental and quasi-experimental studies that
reported on K-12 interactive distance education. The 19 studies were chosen from an
initial pool of 59 studies, of which 40 were eliminated due to insufficient data on student
achievement, failure to focus on K-12 students, or a focus on attitude rather than
achievement. Of the 19 studies, 13 dealt with high school students and six studies focused
on grades 3-8.

The results demonstrated a small positive effect size of 0.147 in favor of distance
education and a greater effect size for hybrid programs (i.e., combined distance and face-
to-face instruction). Hybrid courses with smaller enrollment yielded a greater effect over
online courses alone, suggesting that traditional instruction may be enhanced with the
infusion of an online component. The effect size was positive for all subject areas studied
except foreign languages, which had a strong negative effect size of -0.801. She detected
no significant difference between grade levels, subject areas (other than foreign
languages), ability levels, technology, or the duration and frequency of use of DE or
instructional design. Student achievement was found to be slightly higher in the distance
education environments than in traditional classroom environments.
Cavanaugh (2001) concluded that “supplementing traditional instruction with distance education can enable more reality-based learning, with possible achievement gains” (p.85). The significance of the findings in this analysis has been questioned; the phenomenon of virtual schools was too new to have enough achievement data from students enrolled full-time in online programs (Blomeyer, 2002). This criticism is supported by the fact that there were relatively few studies that met the selection criteria for the meta-analysis. This issue continues to be a problem for fully evaluating K-12 distance education programs using meta-analyses.

Cavanaugh, Gillian, Kromrey, Hess, and Blomeyer’s (2004) meta-analysis of the effects of distance education on K-12 student outcomes is one of the most cited analyses on K-12 e-learning to date. Cavanaugh et al. conducted a statistical review of 116 effect sizes from 14 web-delivered K-12 distance education programs between 1999 and 2004, using U.S. Department of Education’s definition of scientifically-based research as their selection criteria.

The goal of the analysis was to “identify the effects on student outcomes of the features of distance education, including content area, duration of use, frequency of use, grade level of students, role of the instructor, type of school, timing of interaction and pacing of the learning” (p.6). Five studies focused on elementary distance education programs. Two studies focused on both elementary and high school programs. Three studies focused on middle school programs and four studies focused solely on high school.

The weighted mean effect size was -0.028 with a 95% confidence interval, which is not statistically different from zero, indicating that there were no significant differences
in academic achievement between students taught by distance education and students taught in traditional classrooms. No other factors influenced academic achievement in distance education programs positively or negatively.

The number of studies included in this analysis is still very low from which to draw definitive conclusions. In addition, virtual schools and the data associated with them may still be too new to draw any significant conclusions as to the effectiveness of K-12 distance education programs. The researchers recommend that future research should include the evaluation of specific instructional practices that “would lead to results that exceed those in conventional education settings.” (p.18)

Table 2.3: Summary of results of three prominent meta-analyses of K-12 Distance Education

<table>
<thead>
<tr>
<th>Meta-Analysis</th>
<th>Purpose and # of Studies</th>
<th>Results</th>
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</table>
| Barker, 1992                         | Satellite TV adaptations. 3 Studies (referred to as a meta-analysis but there are too few studies to fully consider this a meta-analysis)       | • Academic achievement= no significant difference or better.  
• Less student satisfaction                                                        |
| Cavanaugh, 2001                      | Online Telecommunications 19 Studies 13—high school 6—3rd to 8th grade                   | • Compared to face-to-face instruction, DE outperformed in all subject areas, except foreign language.  
• No significant difference between grade levels, subject areas (except foreign language), duration or frequency of DE; technology; or instructional design |
| Cavanaugh, Gillian, Kromrey, Hess, & Blomeyer (2004) | Web-based Instruction 14 studies 5—elementary 2—elementary and high school 3—middle school 4—high school | • No significant difference in academic achievement between DE and face-to-face students.                                                                                                             |
Smith, Clark, and Blomeyer (2005) synthesized eight new research studies on K-12 online learning, which represent some of the most recent research to date. These studies were the result of a 2004 request for proposal (RFP) distributed by the North Central Regional Educational Laboratory (NCREL) calling for research proposals that adhered to the rigorous study review standards set forth by the Institute for Education Sciences (IES). Table 2.4 provides a summary of six of the eight studies (Cavanaugh, Bosnick, Hess, Scott, & Gillan, 2005; Dickson, 2005; Ferdig, DiPietro, & Papanastasiou, 2005; Hughes, McLeod, Brown, Maeda, & Choi, 2005; Kleiman, Carey, Bonifaz, Haistead, & O’Dwyer, 2005; Zucker, 2005), which have components that directly deal with the effectiveness of online learning for the K-12 students.

Both students and teachers report that interaction is important to learning online. In an effort to increase online interaction, Zucker (2005) rewarded students with extra grade points for increased interaction. However, the results indicated that this incentive was insufficient to increase interaction among online students. Lack of consistency in awarding points by the teachers may explain the lack of a significant increase in classroom interaction (Zucker, 2005).

Online students reported that their teachers were less interested in their progress and less supportive than a face-to-face teacher (Kleiman et al., 2005). Online students also demonstrated less cohesiveness and cooperation, and reported that their teachers were less interested in their individual progress (Ferdig et al, 2005). Related to these findings, Hughes et al., 2005) evaluated the relationship between teacher professional development and students’ perceptions of cohesiveness and teacher support within four virtual and three face-to-face Algebra I classes. Face-to-face students perceived more
cooperation, cohesiveness, and involvement in their classes than the online students. However, the online students perceived they received more teacher support than did the face-to-face students. The teacher sample size was too low to perform a statistical analysis. However, there appeared to be some relationship between the teachers’ number of professional development hours and the students’ perceptions. Teachers with more professional development hours in mathematics content tended to score higher in the students’ perception of teacher support. Those teachers with more professional development hours in the integration of technology scored higher in the students’ perception of cohesiveness (Hughes et al., 2005).

Two studies (Cavanaugh et al., 2005; Kleiman et al., 2005) compared the academic achievement of students enrolled in either an online or a face-to-face (face-to-face) Algebra I course using (a) pretests and posttests, (b) standardized tests, and (c) student grades. The difference in the online and face-to-face students’ posttest scores was borderline significant in favor of the online students. However, online students experienced the greater gain between the pre-tests and the posttests. Face-to-face students were better at simplifying and solving equations, but the online students were better at word problems and problems presented in graphs or patterns (Kleiman et al., 2005). Cavanaugh et al. (2005) reported similar results with Algebra I virtual students outperforming the face-to-face student on the Assessment of Algebraic Understanding standardized exam.

The studies within this meta-analysis exemplify how difficult it is to attain high quality data in the field of virtual high schools. Bimodal results, due to high dropout rates, clouded any decision as to significant difference, but eliminating students who drop
out may create a sample that is not representative of the population (Dickson, 2005). Wide variability and differing components between online and face-to-face courses made it difficult to compare the learning environments (Dickson, 2005; Ferdig et al., 2005). Small sample sizes were problematic, an indication that statistical results should be read with caution. For example, Ferdig et al. (2005) had only 18 online students participate. Hughes et al. (2005) had only 31 online students participate and Cavanaugh et al. (2005) had only 12 online students complete the study. Despite these obstacles, K-12 virtual school research should investigate what goes on inside both online and face-to-face learning environments to identify factors that account for achievement differences, such as social, emotional, and other affective outcomes. Case study methodologies may provide a richer set of data to fully assess such qualitative factors within virtual schooling.

**Conclusion**

e-Learning is not only here to stay in our K-12 schools, but is growing at a rapid rate across the nation. This is particularly true for school districts that have difficulty acquiring and retaining quality teachers, especially teachers for honors and AP courses required to prepare today’s students for college (Cavanaugh, 2004, Hill, 2000; Web-based Education Commission, 2000). Students who do not have access or have limited access to advanced curriculum are at a competitive disadvantage when it comes time to apply for college. Providing equal access to educational opportunities does not mean that all students must take the same Latin course. Rather it means that all students should have access to the same educational opportunities (Kalmon, 2003).
With today’s requirement to respond quickly to the requirements of NCLB and the educational needs of today’s students, educators and policymakers are being forced to solve problems in new ways. Based on the perceived success of e-learning in higher education, policymakers are eager to establish e-learning as the panacea for the lack of qualified teachers and the courses needed by their students. However, it is important to fully evaluate what does and does not work in the virtual school environment, and why, so that our students may experience the full potential of e-learning.
### Table 2.4: Summary of six research studies conducted in 2005 under the NCREL request for proposals (Smith et al., 2005)

<table>
<thead>
<tr>
<th>Research study</th>
<th>Purpose of Interest</th>
<th>Methodology</th>
<th>Site location</th>
<th>Results/ Commentary</th>
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| Dickson, 2005  | To evaluate the distribution of achievement scores of online students. | Analysis of 5 years of student academic performance and persistence (completion of courses and retention) | Michigan Virtual High School | - Final grade distribution was bimodal, indicating some students did well and others did poorly or dropped out.  
- Correlation of activity, measured as the number of clicks in a class discussion board, to final grade was strong and positive ($r = .72$). |
| Ferdig, DiPietro, & Papanastasiou, 2005 | To evaluate online and face-to-face student achievement; ability to predict success; and differences between online and face-to-face students. | Data was collected from students enrolled in 5 classes offered online and face-to-face (face-to-face). Four survey instruments:  
  - Educational Success Prediction (ESPRI)  
  - Two versions of the What is Happening in This Classroom (WIHIC)  
  - A parent survey  
  - Student sample = 410 high school students. Only 68 were online students. 342 were face-to-face students. | Two charter schools:  
  - Appleton eSchool (WI)  
  - Kiel eSchool (WI) | - 248 face-to-face students responded to the WIHIC. Only 18 online students responded.  
- No significant difference was indicated between face-to-face and online achievement scores.  
- Analysis of final course grades and assessments by content area indicated that online student showed some higher scores.  
- The ESPRI instrument predicted with 100% success the course grades for 202 online students in 18 online courses.  
- Face-to-face students scored higher in classroom collegiality and collaboration. |
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<tr>
<th>Research study</th>
<th>Purpose of Interest</th>
<th>Methodology</th>
<th>Site location</th>
<th>Results/ Commentary</th>
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| Hughes, McLeod, Brown, Maeda & Choi, 2005   | To explore online and face-to-face students perception of their learning environment and if online teacher professional development impacts the students’ perceptions. | • Data was collected using the WIHIC survey instrument.  
• Sample size: all high school students-- 31 online students and 85 face-to-face students participated in the study. 7 teachers (combined online and face-to-face) | • 4 virtual Algebra I classes  
• 3 face-to-face Algebra I classes  
• Three different states, but with closely matched curriculum, student population, and location in the same state | • Based on independent-sample t-tests, the face-to-face students perceived higher cooperation, cohesiveness, and involvement in their classes than the online students.  
• Online students perceived more teacher support than did the face-to-face students.  
• Relationship indicated between teacher PD and students’ perception of teacher support, and students’ cohesiveness scores. |
| Kleiman, Carey, Bonifaz, Haistead, & O'Dwyer, 2005 | To examine the effectiveness of Algebra I online learning | • Survey data, observations, focus groups with OL and face-to-face teachers  
• Student pretest and posttest using the Louisiana Educational Assessment Program, the Iowa Basic Skills, and student grades.  
• Sample size: middle and high school students-- 31 schools from 6 districts. 16 offered online courses and 15 offered face-to-face courses. 257-- 8th or 9th grade OL students that completed Algebra I online. | Louisiana Algebra I Online Project via the Louisiana Virtual School delivering to high-need schools lacking qualified teachers | • Online students had higher posttest scores than face-to-face, although the difference was borderline significant (p= .051).  
• The difference between the pretest and posttest scores were significantly different (p=.024) with the online students demonstrating a greater gain.  
• Face-to-face students were better at simplifying and solving equations, but online students were better at word problems and problems presented in a graph or pattern.  
• Unsuccessful students were not included. The control student sample was not given. |
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<tr>
<th>Research study</th>
<th>Purpose of Interest</th>
<th>Methodology</th>
<th>Site location</th>
<th>Results/ Commentary</th>
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| Cavanaugh, Bosnick, Hess, Scott, & Gillan, 2005 | To compare learner outcomes in face-to-face and online Algebra I classes. | • All students took the Assessment of Algebraic Understanding (AAU) after completion of 70% of their Algebra I course.  
• Sample size: high school students--12 virtual school students, and 98 public face-to-face students completed the study | Florida Virtual School | • Of the total 139 virtual students, only 12 completed the AAU exam.  
• Of the 98 face-to-face students, 97 completed the exam.  
• Descriptive statistics were performed and the exam means were 24.08 for the virtual students and 19.43 for the face-to-face students. |
| Zucker, 2005 | To evaluate student-to-student interaction in online courses. | • The control group received specific point value to their grade for the nature and extent of their participation in student-student interaction.  
• The treatment group received double the number of points.  
• Data was collected on the number and quality of interaction, students’ grades, retention rates, and perception of communication.  
• Surveys were taken by both the teachers and the students.  
• Sample size= 282 students—50% seniors, 35% juniors, 11% sophomores, 4% lower grades; 16 teachers | The Virtual High School (Massachusetts) | • Survey response rate= 82% of the students responding and 100% of the teachers responding.  
• 66% of the students and 100% of the teachers felt student-to-student interaction was an important part of their learning.  
• No significant difference between the treatment group and the control group in terms of the affect of increasing points to encourage greater student-to-student interaction.  
• There was no significant difference in the attrition rate and achievement for both groups. |
Issues of low sample sizes, large dropout rates, significant statistical variability, difficulty in making direct comparisons of programs, and hard to measure affective outcomes, provide challenging problems in researching and level of K-12 virtual learning. With the obstacles that K-12 distance education research must over come, it is clear that the “no significant difference” label should not automatically be assumed. It is also important to remember that distance learning programs vary in their quality, just as do face-to-face programs, and that both have a great deal of variation in their outcomes, which affects research comparisons. Although educational institutions prefer to paint a positive picture, not all outcomes in virtual schools are beneficial. Online students are more likely to drop out of school (Harlow & Baenen, 2002; Kozma et al., 2000). Students enrolled in virtual schools are often reported to have greater difficulty turning in assignments on time and students were prone to fall behind (Zucker and Kozma, 2003). Virtual school students show less improvement in listening and speaking skills than do face-to-face students, but greater improvement in critical thinking skills, problem-solving, creative thinking, and decision-making (Barker & Wendel, 2001). In addition to general outcomes, establishing no significant difference is more difficult in some subjects, such as foreign language (Conzemius & Sandrock, 2003), music (Bond, 2002), mathematics, and science (Schollie, 2001). On the other hand, students with specific learning disabilities and attention deficit hyperactivity disorder report more feelings of success and comfort when taking mathematics and science courses within an online any time, any place, any pace curriculum than in their traditional school curriculum (Smouse, 2005). It is clear that matching the program to the students is a very important component to successfully achieve the no significant difference or better goal.
It is even more important is to understand what makes an online course successful for the student. Variation in outcomes may be attributed to flaws in instructional design in some of the virtual high school programs. “Experts say the problem is that most online curricula are simply traditional materials copied to the web” (E-Defining Education, 2002). Distance education program developers have paid less attention to the appropriate blend of media, content and the learner in favor of defining effectiveness in terms of the number of students enrolled and/or student satisfaction (Cavanaugh, 2001). As seen in the studies presented here, researchers are attempting to address policymaker’s emphasis on academic achievement as a measure of effectiveness. Consequently, much of the research is focused on gathering statistical data, yet this research agenda is clearly complicated by the presence of multiple variables that may influence the outcomes of an online course. In addition, the low sample sizes, due to non-participation in the research studies or to students dropping out of their courses, are often associated with virtual school research. These issues make it difficult to draw any decisive conclusions from statistical data. Researchers should not only address the effectiveness of online learning but also why online learning may be effective, which is a qualitative question (Cavanaugh et al., 2004).

Below are recommendations for future research that will help to determine appropriate online environments for our diverse student population within K-12 distance education, including e-learning. Research is needed to:

- Establish best practices for online teaching and learning that serves multiple student populations,
- Document and describe the online instructional models and designs,
• Understand how learner demographics, learning styles, and content areas affect the success rate of online k-12 students,

• Evaluate the impact of one technology at a time to reduce the confusion with the interaction of multiple technologies,

• Understand what motivates an online learner to stay the course, rather than dropout.

We need to address certain gaps in the research before making any definitive conclusions about K-12 distance education. This list calls on researchers to focus on strong theoretical frameworks for the design and analysis of distance education. The focus should include student motivation, persistence, efficacy, and pedagogical effectiveness. To do so, researchers must rely on more than strict quantitative studies and conduct more case studies that fill in some of the gray areas with qualitative methodologies.

In keeping with this suggested research agenda, Chapter 3 details three theoretical constructs: (a) transactional distance, (b) social presence, and (c) motivation to learn. These constructs are thought to affect the quality and success of online courses in higher education, but they have not been studied for their potential affect on virtual school students. Although these constructs may be very important to all virtual schooling, this study will focus on these constructs within the virtual high school environment only.

In addition, mathematics attitudes are discussed due to the content area, Algebra I, within this dissertation. Algebra is the foundation for continuing on to higher mathematics and is considered a critical milestone in secondary education (Cavanaugh et al., 2006). With less than 30% of our eighth grade students proficient in mathematics
(NCES, 2003), and our nation’s students ranking 19th out of 38 countries in algebra
(International Study Center, 1999), our local, state, and national governments have placed
greater emphasis on improving algebra instruction. Since algebra is often required for
high school graduation, the course typically has a larger variation in students in terms of
ability, socioeconomic status, ethnicity, and race. Understanding what instructional
strategies work best in algebra is imperative to provide successful experiences to students
enrolled not only in face-to-face courses, but also those enrolled in distance education
courses.

This study will evaluate the three constructs and mathematics attitudes using both
survey methodology and qualitative case study methods as a means to address some of
the important research questions raised in this chapter.
CHAPTER III
THEORETICAL FRAMEWORK

Introduction

In recent years there have been calls for “rethinking the research agenda” (Perraton, 2000, p. 1) to focus on theoretical principles underlying the use of technology for the delivery of instruction (Benbunan-Fich et al., 2005; Franklin & Bolick, 2005; Garrison, 2000). In response to this call, researchers (Allan, 2004; Berge, 2002; Chen, 2001b; Dutton et al., 2002; Jiang & Ting, 2000; Picciano, 2002) have focused on the application of existing learning theories and pedagogical approaches in e-learning environments with adult learners. This shift may be in response to the hard fact that up to 50% of all adult distance education students drop out of their classes (Moore & Kearsley, 1996). There are many reasons for this high dropout rate, but research into course design and pedagogy informed by established learning theories may shed light on this issue. The dropout rate for virtual school students is equally problematic, with approximately 50% of the students failing to complete their online course(s) (Carr, 2000; Roblyer, 2000; Roblyer & Elbaum, 2000; Rice, 2006; Simpson, 2004). Thus, similar research on the application of learning theories, pedagogy, and course design is needed to shed light on this very troublesome problem with our K-12 virtual school students.

This chapter is divided into five sections that address theories of motivation, mathematics attitudes, transactional distance, and social presence as they are applied in the educational setting, and final a section that considers the e-learning environment and
associated pedagogy. Section I discusses motivation, with a detailed description of the ARCS Model of Motivational Design (Keller, 1979, 1983), which is a comprehensive model of instructional motivation. This model serves at the foundation for evaluating the motivation level of the subjects in this study. Section II discusses mathematics attitudes with a focus on math anxiety and the Fennema-Sherman Mathematics Attitude Scales (Fennema & Sherman, 1976), which is a popular instrument to measure math anxiety in school children. A specific discussion of math anxiety is very relevant since an e-learning Algebra I course is the backdrop of the study. In addition, the level of math anxiety has a major effect on the motivation of the mathematics student. Portions of the Fennema-Sherman scales are used in this study to evaluate the subjects’ level of math anxiety. In Section III, the Theory of Transactional Distance (Moore, 1972, 1980) is discussed as an underlying theory of distance education and its potential for affecting student satisfaction and motivation in an e-learning course. The Scale of Transactional Distance (Zhang, 2003) is used as the instrument for measuring the students’ sense of distance in an e-learning course. A discussion of the Social Presence Theory (Short, Williams, & Christie, 1976) follows in Section IV, which discusses the effect of a students’ sense of presence in an e-learning course on their level of satisfaction and motivation. A description of the Social Presence Survey (Gunawardena & Zittle, 1997) is included in this section as it is used in this study to measure the students’ sense of presence and satisfaction in their e-learning course. Section V discusses recommended pedagogical adaptations to an e-learning course. A table is provided that aligns the supporting research and the recommended pedagogy that helps adjust instruction in light of these four theoretical constructs that affect the motivation and satisfaction of the e-learning student.
Section I: Motivation

The role of motivation in learning has long been a concern for educators, but it is a major issue for those in the world of distance education (Cornell & Martin, 1997; Keller, 1999b; Lin, 1999). The lack of motivation is one of the primary causes for the failure of students to succeed in a distance learning environment (Kim, 2004; Visser, Plomb, Amirault, & Kuiper, 2002). Approximately 50% of all adult and K-12 students in a distance learning course will dropout without completing the course (Moore & Kearsley, 1996). Adult learners who are successful in distance learning environments often are self-motivated and able to structure their own learning (Roblyer, 1999). In some cases this is not the case and research needs to be done to understand what improves motivation.

Self-motivation is also referred to as intrinsic motivation, where the individual performs because of the inherent satisfaction that is gained from the completion of a task (Martens & Kirschner, 2004). Students who are intrinsically motivated learn for the sake of learning and the sheer enjoyment of performing a task. They see their actions as a means of improving their understanding of a concept (Middleton & Spanias, 1999). Positive study behaviors, such as an increase in time on task, choosing more challenging tasks, persistence in the face of failure, increased confidence, and risk-taking, are usually associated with intrinsic motivation, (Middleton & Spanias, 1999).

Extrinsically motivated students perform activities for the sake of material or other rewards that are not intrinsically related to school learning (Husman & Lens, 1999,
Students who are extrinsically motivated are more likely to seek the approval of their teachers, parents, and their peers. They are less likely to take risks in an effort to avoid failure and disapproval (Middleton & Spanias., 1999).

Motivation is also situational and influenced by external factors (Gabrielle, 2003; Huett, 2006; Keller, 1999a).

Teachers and classroom environments can affect student motivation in significant ways. When instruction is meaningful, challenging, and affords a degree of choice, students are more likely to be engaged than when instruction lacks these features. In addition, students are more likely to participate when they establish positive social relationships and feel valued. (Byrnes, 2001, p. 93)

Course design, including the options for interaction, plays a significant role in the level of student motivation to learn, especially in an e-learning environment (Keller, 1999b; Schlager, 2004). Appropriate course design may be equally or even more important at the high school level; yet only a few studies have attempted to investigate motivational factors for the secondary e-learner (Bethea, 2002; Ferdig, DiPietro, & Papanastasiou, 2005; Weiner, 2001; Zucker, 2005).

John Keller (1979, 1983) proposes a model of instructional motivation, the ARCS Model of Motivational Design, based on the synthesis of the literature and research on motivational theory. The ARCS model has been applied to instructional design in a variety of learning environments, including the traditional classroom (Moller, 1993; Small, 1997; Visser & Keller, 1990), adaptive computer-assisted instruction (Song & Keller, 1999, 2001), distance learning (Huett, 2006; Visser et al., 2002), web-based learning (Maushak, Lincecum, & Martin 2000), e-learning (Keller & Suzuki, 2004), and in blended learning, which involves a combination or face-to-face and distance learning
The acronym, ARCS, refers to four essential strategies for designing instruction:

1. **[A]ttention**- the instruction uses strategies to stimulate curiosity and interest;
2. **[R]elevance**- the instruction attempts to satisfy the learners’ basic motives by linking the content to learner’s needs, interests, and motives;
3. **[C]onfidence**- the instruction promotes self-efficacy and positive expectations so that the student feels confident and in control; and

### Attention

Attention refers to the ability of the instruction to capture and sustain the learner’s curiosity and attention. Attention can be divided into three types: (1) perceptual arousal, (2) inquiry arousal, and (3) variability (Keller, 1992 as cited in Gabrielle, 2003). In e-learning the environment should use graphics, animations, or unexpected activities that capture the learner’s sense of curiosity and keep her focused on the course work. To sustain the learner’s attention and curiosity the instruction should utilize “mystery, unresolved problems, or other techniques to stimulate a sense of inquiry in the learner” (Keller et al., 2004, p. 231). Examples of such activities would include asking challenging questions and implementing problem-based lessons. Lastly, attention is best maintained by the introduction of variability in the instruction and activities to avoid boredom.
Relevance

The instruction must be relevant to sustain motivated learners. If the instruction is not seen as relating to the learner’s personal interests, goals, or prior knowledge, the learner is likely to become less motivated. There are three categories that match the three conditions for motivating the learner: (1) motive matching, (2) goal orientation, and (3) familiarity (Keller, 1992 as cited in Gabrielle, 2003). In motive matching, both extrinsic and intrinsic motivation is considered. Extrinsic motivation, such as the desire to pass the course to achieve a new employment position, plays a role in satisfying the learner’s goals. However, intrinsic motivation, such as the desire to successfully complete the course for the sake of the knowledge alone, is a powerful internal motive that also can stimulate the learner to complete a course, especially when the instructional content connects to the learner’s prior experiences and knowledge (Keller et al., 2004).

Confidence

There are three components that improve learner confidence, (1) learning requirements, (2) positive consequences, and (3) personal responsibility (Keller, 1992 as cited in Gabrielle, 2003). Clear goals and learning objectives within the course are highly important so that learners are able to determine exactly what they need to accomplish to be successful. Instructors should provide activities that are appropriate for learners’ abilities such that the learners can appreciate their personal ability to be successful, rather than attributing their success to luck. Tasks should not be too easy or too hard, so that the learner has the greatest opportunity to be successful without assuming that she was not responsible for her own success (Keller et al., 2004).
Satisfaction

For learners to feel satisfied with their learning experience, they must possess a positive feeling about their experience (Keller et al., 2004). The basics for promoting such experiences involve (1) intrinsic reinforcement, (2) extrinsic rewards, and (3) perception of equity play, all of which play a major role in improving a learner’s sense of satisfaction within a course. The instructor is responsible for providing positive rewards and recognition that will boost the learner’s intrinsic motivation, including such supports as immediate feedback and reinforcement. Providing opportunities for the learner to apply what she has learned in her personal life “supports intrinsic feelings of satisfaction” (Keller et al., 2004, p. 232). Learner satisfaction is increased when the learner feels that the expectations of the course were fair and that all students were treated equitably.

ARCS Survey Instruments

Two survey instruments have been developed that measure students’ motivation to learn (Keller, 2006). The Course Interest Survey (CIS) is used to gauge student motivation related to a specific course, and the Instructional Materials Motivation Survey (IMMS) gauges the motivational effect of instructional materials (Huett, 2006). These instruments are designed to measure student motivation within a specific course, and as such, they are situational measures of motivation (Keller, 2006). Both instruments are developed to measure motivational constructs of the ARCS Model of Motivational Design (Keller, 2006) and have been used extensively and validated in multiple settings (Gabrielle, 2003; Huett, 2006; Keller & Suzuki, 2004; Song & Keller, 1999, 2001).
Differing levels of interaction in web-based, tutorial materials may affect a student’s achievement, perception of motivation to learn, and time on task. The interaction in this scenario is between the tutorial and the student in the form of feedback, which ranges from no feedback to proactive feedback that requires the student to apply acquired knowledge in new scenarios. Gao (2001) measured the effect of the different levels of feedback on the students’ motivation to learn using the IMMS survey instrument. Students who received reactive feedback (e.g., “Your answer is correct.”) performed best academically. Students who received proactive feedback that forced the student to apply their original response to a new scenario, performed less well academically. Academic performance was measured by using only a post-test, so there was no comparative measure to assure that there was an actual change in performance. The students who received proactive feedback spent more time on task but were less motivated than those who received immediate, reactive, or no feedback. Providing immediate but not overly challenging or elaborate interaction with instructional material may provide the best design for web-based tutorial instruction (Gao, 2001).

The ARCS design model was used to create three different computer-assisted instructional (CAI) environments with different motivational strategies (Song & Keller, 1999, 2001). The CAI program’s motivational strategies ranged from using no motivational strategies to adapting its motivational strategies to the user. Sixty tenth grade biology students were assigned to one of the three different CAI environments. The results were measured using a simplified version of the IMMS instrument before and after the students were exposed to their assigned CAI environments. A quiz was administered to measure achievement against self-reported confidence. The results
showed that students who were using the motivationally-adapted materials had higher attention and relevance scores and outperformed students using the other two CAI environments. However, there was no difference in scores for confidence or satisfaction, which suggests that further research is needed (Song & Keller, 1999).

Technology-mediated instructional strategies (TMIS) include motivational messages at the beginning and end of each strategy, which are aligned to ARCS model, and supplementary instructional content. Each strategy may be sent to students via email and included motivational messages and links to content available through personal digital assistants (PDAs), CDs, the Internet, or streamed video. Gabrielle (2003) selected twelve traditional face-to-face courses, of various subject matters, and 784 military undergraduate school students, who were assigned randomly to either a control or treatment group. The control group did not receive any design intervention. The treatment group was exposed to the same instructional material but the instruction was enhanced using TMIS. The treatment group demonstrated higher academic performance and a higher level of self-direction in their learning than the control group. Student motivation was measured using the CIS and the IMMS instruments. The results confirmed that the treatment group had higher scores on both motivational scales than the control group. These results confirm the belief that motivation plays a significant role in student achievement and self-directedness (Gabrielle, 2003).

Specific motivational interventions within distance learning environments have been successful in improving student retention rates. Interventions such as revising the instructional design of a course using the ARCS model and using motivational communication methods with students have improved the retention of distance learners
by as much as 80% (Keller & Suzuki, 2004; Visser, Plomp, & Kuiper, 1999 as cited in Huett, 2006). Boise State University’s distance education dropout rate was reduced by 50%, from 44% to 22%, using the ARCS model along with other systematic assessments to identify the cause of their dropout rates and then systematically apply interventions (Chyung, Winiecki, & Fenner, 1999).

Research also supports a finding that academic performance can be significantly improved with systematic interventions designed to improve motivation. Course adaptations, based on the ARCS model’s relevance component of motivation, improve student perceptions of motivation, which resulted in improved academic performance of tertiary distance learning students (Chang & Lehman, 2001 as cited in Keller et al., 2004; Chang, 2005). Huett (2006) reported similar effects on academic performance when confidence tactics, based on the ARCS model, were implemented in a web-based course using a simulation program as the instructional material. In addition, the results showed a significant increase in learner confidence as a reaction to the class. However, there was no difference in reaction to the actual instructional materials. The treatment had an additional result of increasing learner perception of relevance and satisfaction in terms of both the course and the instructional material.

The link between ARCS-based confidence tactics and increased learner confidence may have a significant impact on a learner’s level of self-efficacy and motivation. A learner’s level of self-efficacy corresponds to her internal belief, or confidence, that she can accomplish a given task (Bandura, 1997; Driscoll, 2000; Husman & Lens, 1999; Middleton & Spanias, 1999). Students who have a low sense of self-efficacy, or confidence, are more likely to experience high anxiety in courses they in
which they have experienced nothing but poor results. The link between motivation, self-
efficacy, and math anxiety is well documented (see Hedrick, 2001; Meece et al., 1990).
The next section defines math anxiety and how it affects mathematics achievement.

**Section II: Mathematics Attitudes**

“Although there is no standard definition of the term *attitude*, in general it refers
to a learned predisposition or tendency on the part of an individual to respond positively
or negatively to some object, situation, concept, or another person” (Aiken, 1970, p.551).
When it comes to mathematics, the attitude that researchers often encounter is *anxiety*.
Math anxiety is thought to be a general level of discomfort that results in a lack of
confidence, increased frustration, reduced satisfaction, and a feeling of helplessness
towards mathematics (Ma, 1999).

Where does this attitude originate? Researchers (McDermott, 1956; Morrisett &
Vinsonhaler, 1965; Tobias, 1993) report that many adults experienced their first
encounter with math anxiety in elementary school or at their first attempt at algebra and
higher mathematics in high school. Adults often identify ourselves as dumb at math
(Tobias, 1993) or consider themselves math challenged. Math anxiety grows with the
individual. Research suggests that American students are more likely to enjoy
mathematics in the early elementary grades, but by the time they move into middle
school or high school many students’ enjoyment falters (Middleton & Spanias, 1999).
Elementary students are highly motivated to learn mathematics. They perceive
themselves as competent. They believe that working hard will result in success. However,
during the middle grades many students begin to believe that the subject of mathematics
is special and only smart students are successful in mathematics. All the other students
either struggle or fail (Middleton & Spanias, 1999). The negative attitudes that some students begin to develop in middle school affect their sense of mathematics confidence and expectation for success. Thus, mathematics attitudes are a strong predictor of academic achievement in mathematics in high school (Ho, Senturk, Lam, & Zimmer, 2000; Wigfield, 1994).

Research on math anxiety has lacked of an integrative theoretical framework that conceptualize the relationship among self-perception, affective and performance variables (Meece, Wigfield, & Eccles, 1990). The expectancy-value and self-efficacy theories state that an individual’s behavior is in response to her perceived ability to achieve a specific goal. This suggests that the math anxiety of adolescent students is directly connected to the student’s perceptions of her math ability, and expectations of performance. There is a link between math anxiety and student motivation and self-efficacy (Hedrick, 2001; Meece et al., 1990), as well as mathematics avoidance (Meece et al., 1990; Reynolds, 2003; Tobias, 1993).

It was not only the content but the classroom climate that makes many people anxious about math (Tobias, 1993). Sociological factors in the classroom, such as the presence of competition and peer pressure, influence how students react to mathematics instruction. For example, students may be afraid to appear too smart or too dumb in front of their peers (Tobias, 1993). In addition, relevance is a very important pedagogical factor that plays a role in the level of a student’s math anxiety (Hilton, 1980a, 1980b).

In the past 30 years, mathematics research has investigated the effects of mathematics attitudes on achievement, focusing much of the effort on gender differences. Mathematical knowledge is very important to gain entrance to many careers, yet a lower
percentage of girls than boys elect to study mathematics beyond the minimum
requirements (Fennema & Sherman, 1976). After examining the research of the time
(e.g., Block, 1973; Dornbusch, 1974; Hilton & Berglund, 1971; Horner, 1972; Sears &
Feldman, 1966; Stein & Bailey, 1973; Stein & Smithells, 1969; White, 1959), Fennema
& Sherman (1976) created a ground-breaking survey based on several premises gathered
from the research:

1. Girls experience fear of success in intellectual areas considered male
dominated. This fear operates as a negative attitude that plays a role in
avoiding mathematics. The Attitude toward Success in Mathematics Scale was
included in the survey to assess this problem.

2. Students are more likely to succeed at tasks perceived as appropriate to their
gender. Since girls perceive mathematics as a male domain, they do not
choose to pursue mathematics beyond the minimum requirements. In response
to this issue, the Mathematics as a Male Domain Scale was developed.

3. Attitudes of important people in the lives of students are very influential in the
development of positive or negative attitudes towards mathematics. Thus,
three scales were developed to assess the student’s perceptions of the attitudes
of his/her mother, father, and teacher towards the student as a learner of
mathematics.

4. Girls have less confidence in their ability to learn mathematics, thus it was
considered important to assess the learner’s level of confidence to learn
mathematics. The Confidence in Learning Mathematics Scale was created to
measure the student’s confidence to learn and perform mathematical problems.

5. Many individuals report feeling anxious or a sense of dread when faced with solving mathematical problems. The Mathematics Anxiety Scale was intended to measure the individual’s feelings of anxiety towards mathematics.

6. A student may choose to be more involved with mathematics simply for the intrinsic rewards of enjoyment or the accomplishment of a challenge. Fennema et al. cited White’s (1959) concept of effectance motivation which he postulated was evidenced by an act of “exploration and experimentation…[that is] selective, directed, and persistent…[and] …learned for the sole reward of engaging in it” (White, 1959, p. 323 as cited in Fennema et al., 1976, p. 5). The Effectance Motivation Scale in Mathematics was developed to measure effectance motivation towards mathematics.

7. Males and females perceive the usefulness of mathematics differently. Thus, the Mathematics Usefulness Scale was developed to measure the student’s belief about the usefulness of mathematics.

Although other mathematics attitude scales have been created (e.g., Aiken, 1974; Dreger & Aiken, 1957; Richardson & Suinn, 1972; Wigfield & Meece, 1988), the Fennema-Sherman Mathematics Attitudes Scales (FSMAS) is among the most cited mathematics survey in educational psychology journals (Forgasz, Leder, & Gardner, 1999). It has been validated and used extensively over the past 30 years, either in its full version (Forgasz et al., 1999; Thompson, Melancon, & Becnel, 1993) or in an abbreviated version (Mulhern & Rae, 1998; TERC, 1997). Other researchers have
chosen to use one or more of the individual scales to research very specific issues (Iben, 1991; O'Neal, Ernest, McLean, & Templeton, 1998).

Math anxiety is significantly and negatively related to student perception of mathematics ability and that more girls experience math anxiety than boys (Fennema & Sherman, 1976). In a longitudinal study of middle school and high school students, math anxiety was attributed to negative affective reactions to math, which are represented as nervousness and fear, over a lack of confidence in math (Wigfield & Meece, 1988). In this same study, ninth graders experienced the most concern about their math performance and sixth graders had the least concern about their performance. Both boys and girls reported equal amounts of worry over doing well in mathematics, but girls reported more negative reactions. In another study, middle school students’ perceptions of mathematics ability, performance expectation, and the value of mathematics were found to be closely related to a student’s level of math anxiety, but do not directly affect either the student’s grades or intentions. There was no significant difference between boys and girls in terms of math achievement despite the fact that girls reported lower perceptions of their ability, performance expectations, and intentions to continue to take mathematics. Girls also reported more math anxiety than boys (Meece et al., 1990).

A cross-national study of Australian, Japanese, and American middle school students found that there were definite cultural and ethnic differences in students’ mathematics attitudes (Iben, 1991). Confidence was reported as a significant predictor of mathematics achievement in males in all three cultures. Although confidence was not a reliable predictor of mathematics achievement in Japanese or American girls, in all three cultures girls reported lower confidence in their mathematical abilities. Caucasian
American girls and African-American boys reported the lowest and second lowest intrinsic motivation, respectively. In another cross-national study of Chinese, Taiwanese, and American sixth graders, there was a negative association of the affective factor of math anxiety, as defined by Wigfield & Meece (1988), and mathematics achievement across all three cultures. With the exception of the Chinese students, girls scored higher than boys in terms of math anxiety (Ho et al., 2000).

Caucasian students possess a “higher perception of the mathematics teacher and of the value of mathematics in society” (Rech, 1994, p. 218) than African-American upper elementary and middle school students. African-American males scored higher than females in terms of their self-concept in mathematics and enjoyment of the subject. However, higher-achieving African-American eighth graders scored the lowest on all four scales in the study: perception of teacher, anxiety towards mathematics, self-concept in mathematics, and enjoyment of mathematics, which suggests further research is required to clarify this contradiction. In a study of eighth grade algebra students, ethnicity and socioeconomic status affected algebra achievement. Those students, who were either poor or were a member of a minority, or both, were more likely to have difficulties in algebra achievement (McCoy, 2005). However, there were no gender differences.

The studies discussed up to now have involved traditional educational settings and do not provide insight into how mathematics attitudes affect students taking mathematics through e-learning. There appears to be little or no research on the effect of math anxiety on secondary students taking mathematics in an e-learning environment. Everyone has experience some form of anxiety at one time or another. Often this anxiety is exacerbated by a sense of isolation or embarrassment. There may be a sense that there
is no one to go to for help or comfort, or that no one really understands. There is a perceived distance that seems insurmountable and that no one really knows who you are or what you are feeling. If that anxiety involves a subject, such as math, this perceived distance and personal isolation may feel even stronger in an online course where interaction is a function of separation in time. Immediate responses are not always present as would be the case in a face-to-face class where one might walk up to a peer or teacher to ask for anxiety-reducing help. The next two sections on transactional distance and social presence will discuss how the perception of distance and presence affects learning at a distance.

Section III: Theory of Transactional Distance

What constitutes distance? As defined by the Merriam-Webster dictionary distance is “separation in time… the degree or amount of separation between two points, lines…the quality or state of being distant: as a: spatial remoteness b: personal and especially emotional separation” (Merriam-Webster Online Dictionary, n.d. ¶ 1). Imagine two strangers sitting next to each other in a crowded bus. Neither individual makes eye contact with the other. Neither speaks to the other. Neither acknowledges the presence of the other. These strangers could not be further distant despite their close proximity. As a function of society, distance is a perception that is open to interpretation.

Michael Moore, a leading scholar in distance education, first attempted to define a distance learning theory in 1972 in the era of correspondence courses (Moore, 1972). In 1980, he coined his theory as the Theory of Transactional Distance. The concept of transaction was derived from Dewey and Bentley (1949) and later adapted by Boyd and Apps (1980) as the interaction between “the environment, the individuals, and the
patterns of behavior in a situation” (p.5 as cited in Moore & Kearsley, 1996, p. 200). Moore adapted and applied the concept of transaction to distance education where the situation is characterized by the distance, perceived or real, between the teachers and students.

The transaction that we call distance education is the interplay between people who are teachers and learners, in environments that have the special characteristic of being separate from one another, and a consequent set of special teaching and learning behaviors. It is the physical distance that leads to a communication gap, a psychological space of potential misunderstandings between the behaviors of instructors and those of the learners, and this it the transactional distance (Moore & Kearsley, 1996, p. 200).

The theory states that distance is a function of pedagogy rather than geography. The less dialogue within a course, the greater is the distance. The word “dialogue” is defined not as a simple verbal exchange, but as an “interplay of words, actions and ideas and any other interactions between the student and the teacher” (Moore & Kearsley, 1996, p. 201). The greater the autonomy of the learner, the greater is the distance. This is not to say that the learner should not be making decisions regarding his learning. In a forming a descriptive theory of distance education, a balanced perspective is needed that accommodates both the idiosyncrasies and the independence of learners as a valuable resources rather than distracting nuisances (Moore & Kearsley, 1996).

Structure represents the flexibility of the program’s educational objectives, teaching strategies, and evaluation methods to accommodate each learner’s individual needs. Course structure that has little interaction built-in, as often seen in telecourses, places nearly all of the responsibility on the shoulders of the learner and yet the learner has no input or control over his learning activities (Moore, 1991; Moore & Kearsley, 1996; Zhang, 2003). In this situation the high structure with low dialogue results in a
greater transactional distance. Thus, courses based on VCR tapes, DVDs, or CDs would be expected to result in greater transactional distance unless additional interaction is included in the instructional design. Courses offered via interactive videoconferencing, where there is a lot interaction and less structure results in less transactional distance (Zhang, 2003). Structure alone does not determine the transactional distance within a course.

If structure is high, learners have guidance; but if there is neither dialog nor structure, they must make their own decisions about study strategies and decide for themselves how to study, what to study, when, where, and in what ways, and to what extent” (Moore & Kearsley, 1996, p. 204).

Distance exists in face-to-face courses just as much as it exists in distance courses (Moore, 1991). For example, a lecture-based class of 400 students has a great amount of transactional distance since there is little dialogue and a lot of structure resulting in little flexibility. Following Moore’s theory, education may be analyzed in terms of transactional distance rather than the actual physical proximity of the learner to the teacher. The greater the transactional distance the more likely a misunderstanding will occur between the information the teacher presents and what the student learns. The theory states that distance is a function of pedagogy rather than geography (Dron, 2005; Garrison, 2000; Lally & Barrett, 1999).

The theory includes three types of interactions that are important to the concept of dialogue: 1) learner to content; 2) learner to instructor; and 3) learner to learner (Moore, 1989; Moore & Kearsley, 1996; Zhang, 2003).
Learner-Content Interaction

Learner to content interaction is “…the process of intellectually interacting with content that results in changes in the learner’s understanding, the learner’s perspective, or the cognitive structures of the learner’s mind” (Moore, 1989 as cited in Zhang, 2003, p.34). In agreement with Piaget, Moore states that every learner constructs knowledge through the process of personally accommodating new information into her cognitive structure and that interacting with the content results in this accommodation to construct new knowledge (Moore & Kearsley, 1996; Zhang, 2003).

Learner-Instructor Interaction

Learner to instructor interaction occurs between the learner and the subject matter expert, the teacher. This interaction is highly important as it is the teacher who understands the aim of the instruction, can provide feedback and support, and can help the student in the application of concepts. An absent teacher leaves the student vulnerable to developing misinformation (Moore, 1989).

Learner-Learner Interaction

Learner to learner interaction, or peer interaction, is defined as dialogue that occurs between either individual learners or within a group of learners with or without the presence of the instructor (Moore, 1989; Zhang, 2003). This interaction provides stimulation and motivation to the K-12 learner, but is not particularly important to the adult or advanced learner, who is more self-motivated. Although learner-learner interaction is more important for the young, less experienced learner, it is logical to
assume that this interaction is also very important for those adults and advanced learners that may possess less confidence and self-motivation. In fact, sometimes this interaction is essential for learning to occur (Moore, 1989).

Transactional approach is primarily learner-centered with the objective of providing purposeful interaction between the instructor and the learner and between the learners (Atkinson, 1999). Learner-content and learner-instructor interactions facilitate a knowledge-centered and assessment-centered environment as well, as it supports the learner’s accommodation of new information into her cognitive structure and provides the required feedback interactions for the learner to make appropriate adjustments to her understanding. It is also logical to conclude that the interactions between the learners and between the learners and the instructor result in a community of learners. Thus, if these interactions result in the learners developing a greater sense of presence in the course and a reduced transactional distance then the learning environment also represents a community-based learning environment.

Learner-Interface Interaction

This form of interaction was not included in Moore’s original theory, but several studies have suggested that the interaction between the learner and the learning interface is a very important factor in the concept of transactional distance (Atkinson, 1999; Hillman, Willis, & Gunawardena, 1994).

Learner to interface interaction is a process of manipulating tools to accomplish a task. When dealing with any tool, it is necessary for the learner to interact with the device in a specific way before it will do his or her bidding. To do well in a distance education course, the learner must become proficient in learner-interface interactions… (Zhang, 2003, p. 37).
Figure 3.1 displays the individual relationship of the variables affecting transactional distance. When considering each variable independently, it is clear that the distance increases as each variable leans to the low side. For example, when structure by itself is low, then the transactional distance increases.

![Figure 3.1: Transactional Distance Variables adapted from Lally & Barrett, 1999](image)

However, this figure does not represent the interaction of the variables and the effect of those interactions on transactional distance. For example, if the course structure is low, but the dialogue is high, then the transactional distance is much more likely to be decreased (See Figure 3.2).

![Figure 3.2: Transactional Distance as a function of structure and dialogue adapted from Lally & Barrett, 1999](image)

Although there has been no research in the area of transactional distance in secondary e-learning environments, there is research at the tertiary level. One study
evaluated computer-mediated communications (CMC) as a supportive tool for increasing
dialogue as a basis for forming a community of learners within a Masters of Education
cohort at the University of Sheffield. Using qualitative coding procedures of student
interactions within a cooperative course structure, findings indicated that the increased
dialogue supported by CMC facilitated the construction of an online learning community
(Lally et al., 1999). The increased dialogue supported greater democratization and
equalization of learning within the cooperative structure of the course. Thus, the
increased dialogue and flexible structure of cooperative learning reduced the students’
perception of transactional distance. Similar studies have reported an inverse relationship
of dialogue and transactional distance reported by various researchers (i.e., Bischoff,
1993; Saba & Shearer, 1994).

In a qualitative study that focused on transactional distance within an interactive
videoconferencing environment, learner-instructor and learner-learner interactions were
the highest when the course was highly structured to support discussion prompted by
specific guidelines and questions (Atkinson, 1999). Students located at remote sites had
difficulty participating in the discussions and felt isolated when there was no specific
structure offered by the instructor. However, once the instructor began to offer specific
questions to open the discussion between the local and remote students, the discussions
improved and the remote students reported feeling more engaged and less isolated. This
study also exemplifies the requirement to have built-in structure designed specifically to
compensate for the relative cold nature of videoconferencing.

A study of 121 college students within a videoconferencing course reported that
there was an inverse relationship between transactional distance and learning outcomes
(Chen, 1997). In this study, course structure and learner autonomy did not have a significant effect on learner outcomes. Another study also concluded that the relationship between dialogue and transactional distance was only partially supported and that linkage depended upon the type of dialogue and the classroom situation.

As in-class discussion increased, the transactional distance between the instructor and learners decreased as did the transactional distance among cross-site learners. In-class discussion was not significantly related to the perceived transactional distance among on-site learners. Only out-of-class face-to-face interaction was directly linked with decreased perception of transactional distance among on-site learners. (Chen & Willits, 1998, p.328)

Chen (2001a, 2001b) conducted a similar study to investigate the experiences of 71 college students within a web-based learning environment. Although Chen admits that the sample pool was too small to draw any wide sweeping conclusions, his results support a strong relationship between the learner’s experience and Moore’s model. In another study, The Scale of Transactional Distance (Zhang, 2003) was used to measure transactional distance within web-based college courses. All four sub-constructs of transactional distance were found to be valid and reliable within a web-based learning environment. The most important factor affecting student perception of transactional distance was the learner-to-learner interaction and the least important was learner-to-interface interaction (Zhang, 2003). It should be noted that the data from this study was primarily quantitative with little qualitative data included that might have shed a greater understanding of the learner’s interaction with the interface. Learner satisfaction is closely tied to the course format and structure and the opportunities for interaction, but not to the level of technical support received, which suggests that learner-to-interface is not a strong factor on learner satisfaction (Stein, Wanstreet, Calvin, Overtoom, & Wheaton, 2005).
It is clear from the research that interaction plays a major role in reducing transactional distance whether the learning environment is within a traditional or an online classroom. What is important is that this interaction facilitates a level of connectedness between the participants. Feeling connected to each other comes from establishing a certain social presence, a sense that you “know” your peers and that they “know” you in some way that reduces the perceived distance between everyone involved. The next section discusses how this social presence affects learning at a distance.

**Section IV: Social Presence Theory**

“Social interaction has always been a defining characteristic of education, training, and learning” (LaPointe & Gunawardena, 2004, p. 83). Historically, social interaction has been a focus with educational philosophers, such as Dewey, and educational theorists, such as Vygotsky and Piaget (Driscoll, 2000), as well as a major focus of modern theories, such as Moore’s Theory of Transactional Distance (Moore, 1972, 1973, 1980, 1989, 1991; Moore & Kearsley, 1996) and Bransford, Brown, & Cocking’s (2000) *How People Learn Framework*. How does social interaction make us feel present in the classroom, especially in an e-learning environment?

Social Presence Theory defines social presence as the “degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships” (Short, Williams, and Christie, 1976, p.65). Recent literature defines social presence in essence as the degree to which an individual is perceived as a “real person in mediated communication” (Gunawardena, 1995, p. 151). An individual’s social presence is affected by the medium’s ability to transmit the individual’s body and facial expressions, her non-verbal cues, and appearance (i.e., attire and posture). Different
media have different capacities to project social presence, which has a direct affect on the interactions of the individuals over the media. Social presence is a crucial element of successful teaching and learning via text-based computer conferencing, such as online learning, and represents the “ability of the participants to project their personal characteristics into the community, thereby presenting themselves to the other participants as ‘real people’” (Garrison, Anderson, and Archer, 2000, p. 89). Social presence is considered important to supporting the overall enjoyment of the participants such that they experience a sense of fulfillment within their peer interactions.

Two concepts that are associated with social presence are intimacy and immediacy (Short et al., 1976). Intimacy is affected by the ability of the medium to convey physical distance and human attributes, such as smiling and eye contact. A text-based, online environment has a lower ability to enhance participants’ sense of social presence, whereas two-way videoconferencing has a higher ability to enhance participants’ social presence. The psychological distance between the communicator and the object of her communications is represented as a measure of immediacy. The greater the immediacy, the greater social presence is experienced (Gunawardena, 1995). For example, verbal interactions that are unfriendly and detached offer a low sense of immediacy, whereas friendly and open interactions offer a heightened sense of immediacy. The choice of media may exaggerate or suppress the sense of immediacy between participants’ interactions.

The level of social presence is a function of perception or attitude of the user towards the medium (Short et al., 1976). Individuals may choose to use a specific medium based on the level of social presence required. The individual may choose to
send a letter rather than make a telephone call if there is no reason for the greater level of presence offered by the immediate interaction offered by the telephone.

Two other crucial elements are equally important to successful teaching and learning: cognitive presence and teacher presence (Garrison et al., 2000). Cognitive presence represents the ability for participants to construct meaning through sustained interaction. Cognitive presence may be measured by the quality of the interactions between the participants, such as among the students and between the students and the instructor. Quality is a function of the ability of the students to link ideas to solutions, contribute related outside material to the discourse, and raise in-depth and challenging questions and concepts. However, individuals must possess a level of comfort and safety with their interactions within the community and that comfort comes from a heightened sense of social presence. It is the interaction of both cognitive and social presence that supports quality discourse within an online environment (Garrison, Anderson, & Archer, 2001).

Teaching presence involves the teacher’s influence on the course design and the content, as well as the teacher’s expressions, non-verbal cues, and appearance (i.e., attire and posture). Social and teaching presence work together to provide an environment that supports a climate of critical inquiry, as the facilitation by the instructor and/or fellow students provides the stimulation for driving inquiry within the comfort zone created by the social presence. Cognitive presence may be moderated by teacher presence by the appropriate selection of content, course design, and learning objectives (Garrison et al., 2000; Rourke, Anderson, Garrison, & Archer, 2001).
The Social Presence Theory (Short et al., 1976) has been touted as the most influential theoretical framework in the study of computer-mediated communication (Gunawardena & Zittle, 1997; Spears & Lea, 1992). There is a significant body of research on the implications of social presence in computer-mediated communication in online courses (Gunawardena, 1995). Computer-mediated communication (CMC) has often been criticized as impersonal and extremely low in social presence due to the lack of nonverbal cues and face-to-face components. However, researchers (Baym, 1995; Walther, 1992) postulate that the characteristics of CMC may not be the cause of low social presence, but rather it may be the participants’ perceptions of the CMC media that change their interactive behavior, thus lowering their sense of social presence. In other words, the dilemma here is which came first, low social presence or students’ lack of interactive behavior. Either way, social presence is a strong predictor of satisfaction in a CMC learning environment and an important element of online learning (Gunawardena et al., 1997; Tu, 2001; Walther, 1997).

The Social Presence Survey (Gunawardena & Zittle, 1997) consists of two scales that measure the students’ perception of social presence and satisfaction in a CMC environment. The first scale, the social presence scale, contains fourteen questions that define the concept of immediacy. The second scale, the satisfaction scale, contained ten items that measured the students’ perceptions of learning within a CMC environment and their motivation to continue. The relationship of social presence to satisfaction was evaluated using the Social Presence Scale with 51 students, from five universities, who participated in an inter-university virtual conference. The findings support the concept
that social presence plays a significant role in the satisfaction of students in a CMC learning environment (Gunawardena & Zittle, 1997).

In a mixed methods study, which included a survey instrument, interviews, and observations, the perceptions of social presence of 51 graduate students in an online learning environment was determined (Tu, 2000). The students assigned to either a telecourse design or a face-to-face design of the same course. The same instructor taught both sections and all students used CMC for communications, including class discussion groups. From the results, it was concluded that a new definition of social presence within the CMC environment should be considered. Within CMC, social presence is composed of and dependent upon three elements:

1. Social context,
2. Interactivity, and
3. Online communication.

Social context is a blend of the user’s characteristics and perceptions of the CMC environment. Interactivity includes the types of activities in which the user chooses to engage and her communication style. Online communication includes the characteristics of and applications of the language used online (Tu, 2000). In another study, these same elements were of great importance in determining how Chinese students studying within a CMC environment perceived social presence (Tu, 2001). In particular, to increase the student’s perception of social presence, consideration must be given to the student’s culture, language, computer skills, feelings of privacy (especially important to the
A high perception of social presence is a good predictor of the students’ overall satisfaction with their instructor, as well as their overall perceived learning. There is a positive correlation between students’ perceived learning and satisfaction with the instructor and their perception of social presence within the online course (Richardson, 2001; Richardson & Swan, 2003). A study (Picciano, 2002) examined students’ sense of presence to their actual performance in an online course. Data were collected on the students’ actual participation in online discussions, examination scores, and scores on a written assignment, and then correlated to students’ answers to a satisfaction survey that also included questions on social presence. The results were conflicting. The relationship between student perception of social presence and actual performance on the examination was not statistically significant, but the relationship between perceived social presence and the scores on the written assignment were statistically significant. Since social presence requires students to “socialize, identify with, learn something about the other students, and relate to the personal experience of their colleagues” (Picciano, 2002, p. 33) it might be that those students who positively felt a sense of presence also participated in the discussion boards and consequently might perform better on a written assignment, which was similar to a discussion posting.

Social presence is highly influential on student satisfaction in computer-mediated communication and online learning. The medium chosen to deliver instruction may play a role in the student’s perception of social presence, which in turn may affect the student’s level of satisfaction. Since satisfaction affects motivation to learn (Keller 1979,
1983), it is logical to think that social presence may also affect motivation to learn. “A lack of social presence will lead to a high level of frustration, an attitude critical of the instructor’s effectiveness and a lower level of affective learning” (Rifkind, 1992 as cited in Tu, 2002, p. 34).

**Section V: Pedagogy**

Many researchers and course designers have suggested various strategies, techniques and approaches to facilitate learning in an e-learning environment. These suggestions for adapting pedagogy to an e-learning environment have grown out of the call to develop curriculum that is founded on solid research and theory. Table 3.1 outlines some of the studies that provide specific pedagogical suggestions designed to increase motivation, reduce transactional distance, improve social presence, and reduce math anxiety in an e-learning environment. Chapter Four discusses pedagogy in depth in terms of these constructs, standards and guidelines specific to the teaching of mathematics, Algebra I content standards, and standards for evaluating best practices in an e-learning environment.

As will be discussed in Chapter Four, it is not enough to repurpose teaching materials from the traditional classroom to the online classroom. It is necessary to account for the radically different delivery methodology of e-learning courses and to ensure that students are receiving the same benefits of reform-based instruction that the traditional students receive at their brick-and-mortar schools. Each of the theoretical constructs presented in this chapter must be given serious consideration when developing a pedagogy for an e-learning course to ensure that instruction provides the most motivational learning situation possible, while remaining practical and cost-effective.
Conclusion

Motivation has long been a concern of educators, especially by distance educators (Cornell & Martin, 1997; Keller, 1999b; Lin, 1999). Lack of motivation has been cited as a major cause of failure to succeed by distance education students (Kim, 2004; Moore & Kearsley, 1996). Negative attitudes towards mathematics has long plague many students, not just distance education students, and has affected their motivation to engage in higher mathematics courses and careers that involve mathematics (Fennema & Sherman, 1976; Tobias, 1993). It stands to reason that the interaction of a student’s motivation to learn and mathematics attitudes with her perception of transactional distance and social presence may contribute significantly to the success or failure of the student to succeed in an e-learning mathematics course.

Although there is a wealth of research on distance education in higher education institutions, the research at the secondary level is in its infancy. There are several case studies available describing specific virtual high schools, as well as articles reporting the overall trend in the implementation of virtual high schools (Bradley, 2003; Cavanaugh, 2004; Clark, 2001; Kozma et al., 2000; Watson et al., 2004; Zucker & Kozma, 2003). However, unlike higher education research, there are few research studies that address theoretical constructs that underlie virtual high school experience, and students’ perception of these constructs. This study specifically investigates secondary students’ motivation to learn, mathematics
Table 3.1: Theoretical Constructs and Suggested Pedagogy

<table>
<thead>
<tr>
<th>Theoretical Construct</th>
<th>References</th>
<th>Pedagogical Components</th>
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| **Motivation to Learn** | Badger, 2000; Fullmer-Umari, 2000; Keller & Suzuki, 2004; Priest, 2000; White, 2000 | The goal is to increase the motivation of students to learn.  
1. Use multiple forms of instructional delivery, such as digital videos (QuickTime, etc.), web casts, podcasting, white boarding, animation, tables, and charts  
2. Provide frequent and timely feedback that is constructive and positive  
3. Contact students directly when trouble appears with the student’s progress and provide personal encouragement and help  
4. Provide instructional material that is relevant to the students and gains their attention  
5. Promote confidence and self-esteem |
| **Mathematics Attitudes** | Fennema & Sherman, 1976; Hilton, 1980a  
Middleton & Spanias, 1999; Stolpa, 2004; Tobias, 1993; Waxman & Huang, 1996 | The goal is to reduce math anxiety and increase confidence and enjoyment of mathematics.  
1. Promote different solutions to problems and encourage thinking outside the box and self-realizations  
2. Encourage the asking of questions and participating in discussion  
3. Promote confidence and self-esteem  
4. Provide positive support and reinforcement and refrain from gender and racial bias  
5. Provide material that is relevant and interesting, and avoid rote memorization |
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<tr>
<th>Theoretical Construct</th>
<th>References</th>
<th>Pedagogical Components</th>
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<tr>
<td>Transactional Distance</td>
<td>Anderson, 2003; Collison, Elbaum, Haavind, &amp; Tinker, 2000; Moore &amp; Kearsley, 1996; Swan, 2003; White, 2000</td>
<td>The goal is to reduce the transactional distance between all participants.</td>
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<tr>
<td></td>
<td></td>
<td>1. Provide information and tools that allow the learner to rapidly become familiar with the course expectations, such as electronic syllabi, calendars, organizers, and rubrics</td>
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<td>2. Design the interface to have a logical navigation sequence</td>
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<td></td>
<td>3. Provide activities that encourage students to connect with each other quickly</td>
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<td>4. Encourage active participation in discussions and tolerance for divergent opinions</td>
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<td></td>
<td>5. Provide various methods for communication among students and between students and the instructor</td>
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<td></td>
<td>6. Promote small group interaction and learner self-directed behavior</td>
</tr>
<tr>
<td>Social Presence</td>
<td>Collison et al., 2000; Gunawardena &amp; Zittle, 1997; Richardson &amp; Swan, 2003; Tu, 2000; White, 2000</td>
<td>The goal is to increase the social presence of all participants.</td>
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<tr>
<td></td>
<td></td>
<td>1. Provide activities that encourage students to connect with each other quickly</td>
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<td></td>
<td></td>
<td>2. Provide home page space for students to post autobiographies and pictures</td>
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<td>3. Encourage active participation in discussion</td>
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<td>4. Provide open-ended questions that will stimulate and encourage multiple perspectives in a safe space</td>
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<td>5. Create small group discussions and projects to encourage collaboration</td>
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<td></td>
<td>6. Increase teacher presence by:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. Emailing directly to students with personal welcomes and occasional encouragements</td>
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<tr>
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<td></td>
<td>b. Supporting class discussion through personal interaction with the students</td>
</tr>
<tr>
<td></td>
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<td>c. Providing timely feedback to students</td>
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</table>
attitudes, and perceptions of transactional distance and social presence in an Algebra I course taught via an e-learning environment.

Understanding the student attitudes towards these constructs and their perception of what works, pedagogically, in an e-learning environment is required to ensure that appropriate curricular adaptations are in place to provide the best educational experience and highest level of motivation for virtual high school students. Thus, a discussion of mathematics pedagogy and algebra content, and e-learning pedagogy, including current thinking about appropriate models for ensuring quality instruction and the development of a comprehensive evaluation tool for e-learning algebra courses, will follow in Chapter Four.
CHAPTER IV
E-LEARNING PEDAGOGY AND EVALUATION

Introduction

The purpose of this chapter is to develop a comprehensive evaluation tool that may be used to evaluate an e-learning Algebra I course. The process of developing this evaluation tool requires that various key components be discussed in detail so that one understands the systematic approach that was taken to develop the evaluation tool used in this study.

One goal of e-learning is to provide students access to equal learning opportunities to participate in courses that may not be offered by their schools or district. Another goal is to provide alternative learning opportunities for students who either cannot attend or would prefer not to attend a brick-and-mortar school. Whether educators are evaluating a face-to-face course or an e-learning course, the process is best performed using specific evaluation tools or rubrics so that multiple aspects of a course’s design are taken into consideration with limited subjectivity involved. To evaluate an e-learning course fully, it is necessary for the evaluation to adhere to the standards and principles specific to the content area under review. Since the goal of the e-learning course is to provide an comparable alternative to a face-to-face course, it is not enough to review only aspects of the virtual course that are specific to an e-learning environment. Thus, the e-learning course must adhere to the same standards and principles as must the face-to-face course, so all students receive the same benefits afforded via these standards.
This chapter is organized into five sections. Each section provides background information about an essential component that is considered in building an evaluation tool for an e-learning virtual Algebra I course.

Section I provides an overview of the dropout rates faced in both traditional and virtual schools. The section builds a case for evaluating pedagogy in courses as an important step to combat this problem and as an essential component of any evaluation tool.

Section II reviews Instructional Systems Design (ISD) as a recommended course design process and the starting point for evaluating a course. Since the foundation of course design is an underlying conceptual learning framework, Section III provides a discussion of the *How People Learn Framework*\(^5\) (Bransford, Brown, & Cocking, 2000). This discussion integrates the theoretical constructs of Chapter Three along with other learning theories that support the framework.

The discussion in Section IV provides background about reform-based mathematics and the *Principles and Standards for School Mathematics* (PSSM) (NCTM, 2000) recommended for mathematics education. This discussion includes how the PSSM address mathematics education for at-risk students and the specific PSSM standards for eighth and ninth grade algebra. It is necessary to understand these standards, since the evaluation tool was designed to determine if the online Algebra I course aligns with these standards. This section develops a tool to evaluate an Algebra I course.

Section V discusses e-learning course design and best practices proposed by experts in the field of virtual schooling. Ultimately these discussions form the basis of an

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\(^5\) The name *How People Learn Framework* has become a common title in the literature for what Bransford et al. (2000) referred to originally as the *Perspectives on learning environments* (p. 134). This study uses the title *How People Learn Framework.*
evaluation model that was developed by blending the components necessary to evaluate a traditional Algebra I course with the components necessary to evaluate an e-learning course, so that the tool may used to evaluate an Algebra I e-learning course appropriately.

Section I: Why should we look at pedagogy?

With the increasing demand for e-learning courses for our high school students, there is often a race to develop and implement online courses with little time spent systematically developing effective pedagogy. Although our educational system calls for pedagogical reform in our classrooms with the goal of removing the traditional transmission paradigm (Luca, Cowan, & Mclaughlin 2004), it is still common to see didactic instruction as the mode of content delivery. Petrides (2002) describes the problem in higher education:

Among faculty and administrators, discussions of distance education and distributed learning often focus on what it means as an instructor to teach in this type of environment. Interestingly enough, these conversations at colleges and universities center around how to best deliver instruction to students who are separated physically from their instructor and therefore tend to focus on the medium by which instruction is transmitted, as opposed to discussions of how students actually learn in this environment. (p. 69)

The same can be said of the high school virtual classroom. The lack of development time often results in the repurposing of content to an online environment with little attention paid to current and accepted learning theories and pedagogy. In placing the emphasis on the transmission of knowledge, course developers focus on content design rather than creating a design that facilitates the process of learning (Gunawardena, 2004). Appropriate pedagogy often takes a back seat to content. This approach to course design may undermine the goals of education, especially in an e-learning environment that is notably operating within a different paradigm.
Why should we look at pedagogy? Preventing high school dropout behavior and increasing proficiency is of the highest priority in both our "brick-and-mortar" and our virtual schools (Roblyer & Marshall, 2002). The high school completion rate for traditional schools is a silent epidemic, with one-third of the nation's students failing to complete high school. The drop out rates are disproportionately higher among low-income and minority students who attend urban and inner city high schools. The completion rate for minorities is approximately 50% (Bridgeland, Dilulio, Morison, 2006).

When at-risk students within traditional schools are asked why they choose to drop out, several reasons are given. These reasons can be categorized into three primary issues: (1) poverty and teen pregnancy; (2) academically unprepared; and (3) unmotivated.

- **Poverty/Teen Pregnancy**: A student needs to get a job to support her family or her own child. The student missed too many school days, either for work or illness, to catch up on her school work.

- **Academically Unprepared**: A student falls behind in elementary or middle school and is poorly prepared academically for the rigors of high school. Consequently, he can not keep up with the school work and fails. The next year he repeats part or all of the prior year, and he does not feel confident he can meet the graduation requirements.

- **Unmotivated**: Her classes are simply not interesting to her. She is not motivated or inspired to do her work. With too much freedom and not enough rules in her life, she spends too much time skipping school with others who
are not interested or motivated in school. High drop out rates are often associated with the lack of parent presence and engagement. Parent’s work schedules often keep them from keeping up with the child’s academic performance (Bridgeland, Dilulio, Morison, 2006).

Effective pedagogy does not prevent poverty or teen pregnancies, but it may improve issues associated with the lack of academic preparedness and the absence of motivating curriculum. The role of effective pedagogy in reducing the dropout rate is echoed in what these at-risk students say would improve their chances of staying in school (Bridgeland, Dilulio, Morison, 2006). The students’ suggestions speak directly to the issues underlying the dropout phenomenon listed above.

- **Poverty/Teen Pregnancy**: Provide better communication between the parents and the school to encourage parents to take a greater role in making sure their child attends school.

- **Academically Unprepared**: Maintain smaller classes so more individualized instruction may occur.

- **Unmotivated**: Use relevant and interesting curriculum that incorporates opportunities for real-world learning experiences. Increase the supervision in school to be sure students are attending their classes.

Virtual high schools are a product of districts' desires to expand educational opportunities for their students. The vision of virtual high schools is to provide access to courses that are not offered within the district, as well as to provide an alternative for students who cannot or choose not to attend traditional school. Students may attend a virtual school to accelerate their learning opportunities, to continue their studies while
they are homebound or maintaining a work schedule, or to retake a course they failed. 
Thus, students who have dropped out of their traditional school may find the virtual high 
school an answer to their problems. Some virtual schools have reported high completion 
rates. However, despite all good intentions, other virtual high schools have lower 
completion rates. The completion rates may be different between semesters. 

Some programs like IVHS [Illinois Virtual High School] that are known to be 
successful have higher dropout rates in the summer, when credit-recovery efforts 
go into high gear. In other semesters, the dropout rate goes down to an average 
15%. (Roblyer, 2006a, p. 33) 

It is very important to understand what the differences are in these schools so we may 
ensure that all virtual schools are able to serve all students. 

Clear statistics on the dropout rates within virtual high schools are difficult to 
determine, as each school defines what is considered a “dropout student” differently 
(Roblyer, 2006; Zucker & Kozma, 2003). Many virtual high schools have grace periods 
during which a student may discontinue a class and not be considered as a dropout. The 
Florida Virtual School (FLVS) has a grace (drop-add) period of approximately one 
month, during which students who leave are not considered dropouts. For example, in an 
Algebra II course, 30% of the students may drop before the end of the grace period and 
another 25% may drop after the grace period. Is the dropout rate 25% or 55%? Similarly, 
30% of students initially enrolled in Calculus may drop during the grace period, but after 
the grace period 99% of the remaining students finish the course. Is the dropout rate 31% 
or 1%? The dropout rate that is officially reported in both cases is the lower number. It 
should be noted that some of the discrepancy in these figures is due to students who sign 
up without the appropriate pre-requisite courses completed and they are subsequently 
withdrawn from the class during the grace period (Dickinson, 2006).
The reality of e-learning in virtual high schools is that the dropout rates vary but may be high in many programs (Carr, 2000; Roblyer, 2000; Roblyer & Elbaum, 2000; Rice, 2006; Simpson, 2004). Roblyer (2006a) states that “dropout and failure rates for virtual programs are reported to be as high as 60% to 70% in some locations” (p. 32). If providing e-learning options at the secondary level is specifically designed to accommodate students’ need for alternative educational opportunities, then why are some virtual high schools plagued by high dropout rates and others are not? The answer to this question may lie in the difference in program design and pedagogy. Less successful schools may be using problematic pedagogy that is not grounded in learning theories that support this new learning paradigm. Not all students “may play well in the virtual sandbox” (Roblyer, 2006b, p. 1). Online high school students who are not high achievers, and who have low reading and comprehension skills, are not likely to succeed and may drop out at higher rates. “It is not surprising that programs that enroll a high percentage of at-risk students are much more likely to have high dropout and failure rates” (Roblyer, 2006a, p.33). The high flexibility of an anytime, any place, any pace learning program offered by some virtual high schools may simply mean no learning for students with poor time management or technology skills (Roblyer, 2006a). Some students may resist the change in the student-teacher roles, where students are expected to take an active role in their own learning. This reaction may be exacerbated by the perceptions of isolation, lower classroom interaction, and the lack of contextual clues that help both the student and the teacher realize when a student may be in trouble (Kennedy, 2002; Kirby & Roblyer, 1999; Zucker/Kozma, 2003).
With the continued growth of secondary online instruction, the need to identify what pedagogy is best suited to ensure effective, theory-based instructional practice continues. It stands to reason that the pedagogy needs to address the delivery method and the content to be delivered. Content and the associated goals of that content vary significantly from one subject to another. Although many of the instructional strategies may apply to multiple subjects, it is not appropriate to generalize how each subject should be taught. Beyond issues of a specific content, there are issues associated with the nature of the audience and the environment in which the audience is attempting to learn. What works with one audience may not work for another. What works within one learning environment may not work in another. There is a relationship that exists between pedagogy, the audience, the content, and the environment that cannot be generalized (Bowen, 2006; Dick, Carey, & Carey, 2001; Kearsley & Moore, 1996).

In this study, Algebra I is the content of interest. Algebra I is the gatekeeper for all higher mathematics offerings within high school (Hass, 2005; Rettig & Canady, 1998; National Academy of Sciences, 1998; Paul, 2005). Despite efforts to increase student understanding of algebraic concepts, student performance is "characterized as an unmitigated disaster for most students" (National Academy of Sciences, 1998, p. 1). Successfully completing Algebra I is a challenge for many students. Students often fall behind early in the course and are unable to understand the next, more complex concepts as the course progresses. This pattern results in students failing the course and retaking the course to recover the required credits. Consequently, students begin the recovery process already lacking confidence in their ability to learn algebra (Rettig & Canady, 1998).
Gabriela Ocampo, from the Los Angeles Unified Schools, is a prime example of this cycle.

Each morning, when Gabriela Ocampo looked up at the chalkboard in her ninth-grade algebra class, her spirits sank. There she saw a mysterious language of polynomials and slope intercepts that looked about as familiar as hieroglyphics. She knew she would face another day of confusion, another day of pretending to follow along. She could hardly do long division, let alone solve for x. . . . Gabriela failed that first semester of freshman algebra. She failed again and again—six times in six semesters. And because students in Los Angeles Unified Schools must pass algebra to graduate, her hopes for a diploma grew dimmer with each F. Midway through 12th grade, Gabriela gathered her textbooks, dropped them at the campus book room and, without telling a soul, vanished from Birmingham High School. . . . Hundreds of her classmates, along with thousands of others across the district, also failed algebra. (Helfand, 2006 ¶ 1).

Many school districts are looking for alternatives to adjust the algebra curriculum to serve the previously unsuccessful student, such as Gabriela, through self-paced remediation using online software. Others are implementing online algebra classes that mirror the face-to-face classroom (Fratt, 2006). However, if the curriculum and pedagogy in the brick and mortar algebra course cannot accommodate students so that they do not fail, how can repurposing the course to an online solution be any better?

In this section, an argument was presented for why it is necessary to include pedagogy in the evaluation of virtual courses, since it is these courses that many administrators hope will solve the dropout rates in our high schools. In addition to improving pedagogy, another key to improving either a face-to-face or an e-learning course is to follow a systematic process for course design that considers the learning environment, the content, the audience, and the pedagogy. Whether one is designing a traditional course or an e-learning course, the process is the same. In the next section, instructional systems design will be discussed, emphasizing the value in e-learning, but
recognizing that this process is equally valuable in face-to-face course development. Due to the value of quality course design, it is now necessary to understand the process and include the key components of course design in the evaluation tool.

**Section II: Instructional Systems Design**

Many e-learning courses are created under the pressure of a short deadline. Meeting a deadline often supersedes the need to design the course systematically. This practice is beginning to change as course developers recognize that definite prerequisites exist to produce effective e-learning experiences (Bowan, 2006; Moore & Kearsley, 1996). The design of a course is closely related to its effectiveness. This is especially true when the visual cues between participants are missing, which may often be the case in e-learning courses. Whether developing a face-to-face course or an e-learning course, many curriculum developers use some systematic approach and team work to course design. Other courses are successfully designed by an individual rather than a team. However, even these individual designers consult with the teacher, the administrator, and other key players before, during, and after the design process. Consequently, these individuals are often following a design process that is very similar to a systematic approach without referring to the process as an instructional system design.

Instructional Systems Design (ISD) is an accepted approach to develop courses that systematically following circular process that begins with a needs analysis and proceeds through the design, development, implementation, and evaluation of the course. The design process translates learning and instructional theory into plans for the delivery of quality instructional materials and activities (Siemens, 2002). It is an iterative process that requires ongoing evaluation and feedback. The feedback loop is a living
process to adjust for problems discovered during the development (Dick, Carey, & Carey, 2001). Although other ISD models may be used, Moore and Kearsley (1996) proposed using the ADDIE design model (see Figure 4.1) for systematically developing distance education courses, which today include e-learning.

![Figure 4.1: ADDIE instructional systems design](image)

Each phase of development involves the completion of multiple tasks (see Table 4.1), which are subject to scrutiny as feedback provides additional information that may require adjustments to the course design.

Table 4.1: ADDIE phases and corresponding tasks (Adapted from Moore & Kearsley, 1996)

<table>
<thead>
<tr>
<th>Design Phases</th>
<th>Design Tasks</th>
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</table>
| Analysis      | • Identify the characteristics of the learners and the learning environment  
                • Identify what the students need to learn to perform specific required skills or tasks (often referred to as task analysis) |
<table>
<thead>
<tr>
<th>Design Phases</th>
<th>Design Tasks</th>
</tr>
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</table>
| Design       | • Set goals and objectives  
              • Determine structure and format of the course  
              • Select media based on goals, objectives, and analysis information |
| Development  | • Create, test, and produce instructional materials  
              • Train teachers and staff |
| Implementation | • Enroll students and deliver any instructional materials to students  
                  • Conduct the course |
| Evaluation | • Gather data on effectiveness of the course, which includes achievement data, other assessments of student progress, and evaluation information on the effectiveness of the course and materials  
                  • Revise as appropriate using the feedback and returning to the analysis phase. |

There are two caveats, which may limit the effectiveness of most instructional designs and should be taken under consideration when beginning the process. ISD has been criticized as promoting very prescriptive curriculums. Caution should be taken to ensure that all teacher creativity is not removed from the curriculum through the ISD process. In addition, the lack of adequate resources to follow a strategic development plan often poses a problem for many institutions. Course development is often seen as a team effort. Each design phase requires multiple individuals to complete the corresponding tasks adequately (Moore & Kearsley, 1996), but educational institutions, especially public education institutions, may not have the money or the personnel resources to form such a team. Ultimately, the “Cadillac” version of course development in virtual high schools may not be realistic without dedicated funds.
This section discussed the recommendation of following a solid and systematic design process to develop quality courses. To fully evaluate a course, one should give consideration to how well the course is designed for the audience and content. Learning theory is the foundation of ISD, but when the design process is aligned with the behaviorist approach the process may, indeed, become very prescriptive. Seen through the lens of the behaviorist, the objectives, activities, and criteria are created to transfer knowledge rather than encouraging the learner to construct knowledge, a much more interactive approach to learning. Choosing the appropriate underlying learning theory and following an iterative approach is highly recommended for developing a course that meets the needs of the learner and delivers the necessary content (Jonassen et al. 1997; Shiffman, 1995). The next section will discuss the *How People Learn Framework* and the underlying constructivist learning theories used to develop the framework. Additionally the constructs from Chapter Three will be revisited as an enhancement to the framework for an e-learning environment. This discussion will be used to form the learning theories that underlie the evaluation tool developed in this chapter.

**Section III: How People Learn Framework**

[Online courses require]... the use of the Internet to access learning materials; to interact with the content, instructor, and other learners; and to obtain support during the learning process, in order to acquire knowledge, to construct personal meaning, and to grow from the learning experience (Ally, 2004, p.5).

This statement brings to focus the infusion of many underlying constructivist learning theories that contribute to online course development. Constructivist approaches to learning have been demonstrated as central to the success of online learning through the building and interaction of a community that functions as a society of learners (Carr-
Chellman, Dyer, & Breman, 2000; Galloway, 2001; Jiang & Ting, 2000; LaPointe & Gunawardena, 2004; Luca, Cowan, & McLoughlin, 2004; Talvitie-Siple, 2005). It is important to understand how online learning is informed by these learning theories. Is it possible to conduct instruction in an online course that is true to the content and incorporates principles of good practice informed by theory, such as:

- Collaborative learning and mentoring,
- Construction of knowledge,
- Respect for prior knowledge and social/cultural exploration,
- Learning by discovery and deliberate practice,
- Meaningful and authentic assessment, and
- Learning for understanding not memorization?

It might make sense to begin this discussion with a summary of the individual learning theories, but most of the theories that are prominently considered in online learning and mathematics education fall within the scope of the How People Learn Framework (Bransford, Brown, & Cocking, 2000). The following discussion will review constructivist-learning theories in light of this framework.

The How People Learn Framework incorporates concepts of learning and teaching that are based on a broad overview of research in education, social and cognitive psychology, neuroscience, and human development. Through this extensive research three key principles form the foundation of the framework (Donovan, Bransford, & Pellegrino, 1999).

1. **Preconceptions**: Students have preconceptions about the world and how it works. If the students’ preconceptions are not engaged during the learning
process then the students may not fully grasp the new concepts they are taught and they may revert to their prior knowledge. These preconceptions may be accurate or not. Instruction that considers the students’ understanding of how the world works provides an opportunity for the students to make sense of new concepts in reference to their preconceptions. Such a process allows the students to restructure their understanding of how the world works.

2. **Competence:** For students to become fully competent, or experts, in a given subject, the students must not only have a deep understanding of the facts and ideas, but also to be able to put the pieces of information together to frame a concept. They must possess the ability to apply this factual knowledge appropriately in new situations. The difference between a novice and an expert is the ability to see and apply the nuances within a concept.

3. **Metacognitive Instruction:** Teaching and modeling metacognitive strategies to students allows the students to take control of and monitor their own learning. Students can learn to engage in internal conversations about what they know and what they need to know to understand concepts fully. They can take ownership of their learning.

To accommodate these principles, the *How People Learn Framework* proposes a learning environment that represents the interrelationship of four design perspectives:

1. Learner-centered,
2. Knowledge-centered,
3. Assessment-centered, and
4. Community-centered (See Figure 4.2).
**Learner-Centered Environments**

Learner-centered environments focus on the learner and the prior knowledge, skills, attitudes, and beliefs of the learner. The learner is encouraged to use her prior knowledge as an initial foundation to construct and reconstruct knowledge from new information. Thus, prior knowledge plays a major role in learning. Through the process of evaluating and reevaluating information, the individual’s knowledge is in constant flux in an attempt to maintain a level of equilibrium.

![Figure 4.2: How People Learn Framework](Bransford et al., 2000, p. 134⁶)

Piaget stated that to maintain cognitive equilibrium an individual employs two processes when encountering new information: assimilation and accommodation. When the individual is able to make sense of new information by applying the rules developed from his prior knowledge then the individual has assimilated the information. The new

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⁶ Bransford et al. 2000, p. 134 refers to this model as the Perspectives on Learning Environments, but has renamed it as the How People Learn Framework.
information is classified and merged with his prior knowledge. However, if the individual must alter his prior knowledge to account for the new information, then the individual makes sense of the new information by making an accommodation within his prior knowledge. The yin and yang of assimilation and accommodation maintains the cognitive equilibrium of the individual (Bjorklund, 2000; Driscoll, 2000).

The concept of assimilation is supported by Ausubel's Assimilation Theory, which states that new and old information interact to form more highly differentiated cognitive structures. Cognitive psychologists later coined the term "schema" to represent an individual's existing concepts, theories, procedures, and models, by which the individual compares all new information. An individual's schema is the foundation used by the individual to interact and assimilate new information through fine tuning and restructuring, which ultimately results in the schema changing to account for new information that does not fit within the prior schema (Driscoll, 2000).

A learner-centered classroom is also a culturally responsive and relevant classroom. The individual's society plays a major role in the learner’s process of making sense of the world. Individual development is a function of the cultural context in which the individual is raised. Children acquire knowledge through their culture, and this culture provides them the processes or means for their thinking. Thus, culture teaches children both what to think and how to think. This culturally specific prior knowledge is highly influential in how the child processes new information. The learning of one individual occurs through another individual. "The path from object to child and from child to object passes through another person" (Vygotsky, 1978, p. 30).
The process behind how an individual “knows,” his way of knowing, has a social origin. Within the individual's society, members interact and share ideas and knowledge. Teachers and students form a community of learners who take responsibility not only for their personal learning but also the learning of those in the community (Vygotsky, 1978). In this community, one member may be more knowledgeable about a subject than the others, and for a short period assumes the role of the teacher. In another moment in time, another individual may function as an expert from who all others learn new information. Through this interaction and exchanging of roles within his community, an individual adopts and internalizes a new way of knowing. In this community, the learner is always the focus.

*Knowledge-Centered Environments*

The information and activities that help the student to acquire the understanding and skills necessary to become a productive member of society are the focus of knowledge-centered environments. Subject matter standards are recognized as important guidelines that help the student to achieve these required skills and knowledge. Learner- and knowledge-centered environments overlap in the classroom when students relate to the content from their personal experiences, learn by "doing" and make sense of the information and skills acquired through cognitive analysis. Students are encouraged to construct knowledge through the application of metacognitive skills, rather than simply memorizing facts. Metacognitive mediation is the resolution of conflicting internal thought through the use of semiotic tools through which we form meaning of our world.
Mediation is a mechanism for learning. It is the means by which we apprehend the world, make predictions, and develop meaning (Vygotsky, 1978).

Metacognitive mediation has its strongest roots in interpersonal communication. Consequently language is the primary semiotic tool by which mediation of internal thought occurs. Learning occurs through intrapersonal and interpersonal communication (Karpov & Haywood, 1998). Language, as a semiotic tool for mediation, develops over time within the individual. An individual moves from social speech, typically associated with the very young child, which represents speech without thought, to private speech that is audible and used to solve difficult problems, to inner speech, which is the process of thinking in words or thinking through a problem internally (Byrnes, 2001; Driscoll, 2000; Miller, 2002). Inner speech is defined as "pure meaning" (Vygotsky, 1986, p. 149). One might postulate that as the individual's understanding of a problem increases, the individual employs more inner speech and the knowledge is internalized. Thus learning is a function of verbal interaction with others, or as Vygotsky put it, "Thought is born of words…" (Vygotsky, 1978, p. 282).

**Assessment-Centered Environments**

Feedback, self-assessment, and revision opportunities are the focus of the assessment-centered environment. It is important to assess for understanding rather than to measure the memorization of facts or procedures. Formative assessment is a key component of the assessment-centered environment that provides students a continuum of feedback rather than the extensive use of single-point-in-time examinations. "Instruction is only useful when it moves ahead of development…leading the child to carry out
activities that force him to rise above himself" (Vygotsky, 1978, p. 212-213). There is a space or “zone” where the child learns best. The zone of proximal development (Vygotsky, 1978; 1986) is the space between what the child can accomplish without the help of the teacher and what the child cannot accomplish without the help of the teacher. The child’s zone represents the potential learning on which the teacher should focus and provide guidance (Figure 4.3). The teacher, working within the child's zone, must encourage the child to explain concepts independent of the instructor or others. Learning leads development and the role of the teacher and other experts is to push the student along within his zone until he has internalized the information and is ready for more challenging information (Bjorklund, 2002; Driscoll, 2000; Miller, 2002).

![Figure 4.3: Zone of Proximal Development from Galloway (2001)](image)

What is important is the positive process of change, rather than a single moment in time. In light of the continuum of feedback and the student’s ability to respond with revisions, the assessment-centered perspective overlaps previous perspectives since each perspective encourages the student to relate to and to absorb the information in a manner that perpetuates the learning process. This concept is illustrated in Figure 4.4.
Community-Centered Environments

In the HPL model these environments intersect and are encapsulated in community-based learning environments, of which collaborative groups and active interactions are central (Bransford et al., 2000). “[E]very human thought is adapted to the environment, that is, situated, because what people perceive, how they conceive of their activity, and what they physically do develop together” (Clancey, 1997, pp.1-2.). Learning is a product of sociocultural situations. This situated cognition shifts the emphasis away from the individual to the sociocultural setting, where learning occurs through participation in the society’s practices. This community of practice is the foundation from which knowledge is distributed between its members. No individual is a member of only one community of practice. An individual’s knowledge grows from a blend of experiences gathered from the “lived practices” (Driscoll, 2000, p.156) within the multiple communities of which one is a member (Driscoll, 2000; Lave & Wenger, 1991).
The classroom functions as a community of practice where an inquiry-learning environment develops that allows students to share perspectives and collaborate to discover solutions. Instructional activities are developed with consideration of the student’s past experiences, needs, capacities, and predispositions, such as the student’s motivation and characteristics (Bruner, 1966; Dewey, 1938). Students are not overly directed; rather they are allowed to explore within their community options for problem solving. As in the learner-centered environment, the traditional teacher-student roles evolve into a co-facilitative relationship. The ideal classroom is democratic. Both the teacher and the student would develop aims for the classroom activities. The student would be involved in setting his own learning objectives. Learning is accomplished through practice within the society and for the benefit of society. Therefore, assessment is authentic, formative, and in-situ (Dewey, 1938).

Reconsidering the original HPL framework (see Figure 4.2) and learning theories that support this framework, it is useful to redraw the framework in light of the supporting theories (see Figure 4.6).

Motivation

The constructivist theories that underlie How People Learn Framework rely on the teacher’s ability to instill self-regulatory skills that provide the student with the ability to form a partnership with her teacher and peers. The student must have the ability to develop her educational goals and to take ownership of her learning and achievement. Students historically have not taken such an active role in their learning. Rather, teachers are the active participants, attempting to transfer their knowledge to their passive
students. But if the priority in our educational system is to create active learners, engaged in every aspect of their education, then we must consider what affects a student’s motivation to learn.

Figure 4.6: The relationship of constructivist learning theories to the *How People Learn Framework*

There is a link between self-efficacy and motivation. The motivation to learn comes from the learner's internal belief that she can accomplish a given task (Bandura, 1997; Driscoll, 2000; Husman & Lens, 1999; Middleton & Spanias, 1999). People make judgments about what they are and are not capable of accomplishing. Results from the past play a major role in a student’s motivation to engage in a new task in the future. If an individual's self-efficacy is low then the individual is less likely to take action to accomplish the desired outcome. A student who has experienced nothing but poor results and anxiety in a subject area may have a low sense of self-efficacy and be much less motivated to work harder to improve. For example, research studies (e.g., Hedrick, 2001;
Meece et al., 1990) support the link between math anxiety, motivation, and self-efficacy. Math anxiety is a strong predictor of academic achievement in mathematics. Those students who experienced high math anxiety perform poorly. Those students that do not suffer from math anxiety may have a greater sense of self-efficacy enhanced by successful experiences and verbal encouragement from others who believe the individual is capable of accomplishing the outcome (Hedrick, 2001; Ho, Senturk, Lam, & Zimmer, 2000; Meece et al., 1990; Wigfield, 1994).

Motivation can also be said to be situational and influenced by external factors (Gabrielle, 2003; Huett, 2006; Keller, 1999a). The role that the teacher and student play influences this delicate relationship and sets the tone for the classroom. The amount of engagement the student has with the content and instruction, the options for interaction, the considerations for the student’s prior knowledge, and the control the student has over his learning all play a significant role in the level of the student’s motivation to learn (Byrnes, 2001; Keller, 1999b; Schlager, 2004).

These external factors are also pedagogical phenomena that influence the transactional distance associated with e-learning that is experienced by the student. Balancing the course structure, dialogue, and degrees of learner autonomy plays a significant role in reducing the student’s perception of distance in a virtual course (Moore, 1989; Moore & Kearsley, 1996). It stands to reason that increased transactional distance may result in a reduction of student motivation. The reduction of transactional distance is most often related to the level of interaction within a course, especially within an e-learning course. Interaction among the students and between the students and the instructor improves the participants’ perception of social presence, and consequently may
reduce the transactional distance. In concert with course interaction, the specific delivery medium influences the sense of intimacy and immediacy associated with social presence in a course (Gunawardena, 1995; Short et al., 1976). Interactions and media that provide positive experiences that help the student feel “known” within the course increases the student’s motivation to participate and facilitates his learning (Richardson & Swan, 2003; Weaver & Albion, 2005).

The process of motivating students is complex in any educational setting. Teachers and course designers must balance pedagogical issues that deal with the student’s preconceptions and prior knowledge, the influence of culture and societal associations on student’s perceptions, and the effect of experiences on the student’s self-efficacy and attitudes. e-Learning complicates the process with the added influences of transactional distance and social presence on the motivation of online students. The issues associated with motivation are relevant to the How People Learn Framework (Bransford, Vye, Bateman, Brophy, & Roselli, 2004). Every aspect of HPL can affect a student’s motivation to learn. Figure 4.7 represents an adaptation of the framework that relates motivation, and the associated e-learning constructs, in respect to the original framework.

This section discussed the importance of understanding the learning theories that are the foundation of modern, reform-based pedagogy and that serve as the gold standard when evaluating courses. The inclusion of theoretical constructs from Chapter Three adapts this framework for an e-learning evaluation tool. The next section will discuss how the PSSM (NCTM, 2000) align with the How People Learn Framework and the importance of including consideration of the PSSM in a tool that will evaluate not just
any e-learning course, but an Algebra I e-learning course. As part of the steps to building a comprehensive evaluation tool for e-learning Algebra I courses, the next section will develop an evaluation tool for traditional Algebra I courses that will ultimately be merged with e-learning best practices to form the final evaluation tool used in this study.

![HPL framework in relation to motivation, transactional distance, social presence, and self-efficacy](image)

Figure 4.7: HPL framework in relation to motivation, transactional distance, social presence, and self-efficacy

**Section IV: NCTM Mathematics Standards**

In an effort to increase mathematics achievement, the National Council of Teachers of Mathematics (NCTM) has placed emphasis on reforming mathematics pedagogy, including algebra, by emphasizing constructivist pedagogy. The intent is to move away from traditional, dull assignments and lectures that make little sense to
students, rarely connect to the students’ life experiences, and often result in decreased motivation to achieve in mathematics (Linn et al., 2000). When online courses are designed and evaluated, it is appropriate and necessary to assess the corresponding pedagogy to ensure that it is aligned with the NCTM reform-based pedagogy (NCTM, 2000), but also allows for adaptations that fit the unique requirements of e-learning instruction.

Prior to designing a course, it is necessary to identify the standards that guide the development of the course (Dick et al., 2001; Moore & Kearsley, 1996). These standards are used again to develop an evaluation tool specific to the subject, the educational level, and the expected audience within the course under evaluation. The term “standard” is often synonymous with terms such as, “yardstick,” “model,” and “example.” Standards are set to assure consistency and quality. Ravitch (1995) defined three different forms of standards within education.

1. **Content standards** govern what will specifically be taught in a subject. For example, the National Council of Teachers of Mathematics (NCTM, 2000) set forth specific algebra standards for all academic levels in their *Principles and Standards for School Mathematics.*

2. **Performance standards** define the level of mastery a student has attained within the subject. The level of a student’s mastery is often measured by an examination, but may be measured through other assessment tools such as projects, portfolios, discussion contributions, or interviews. For example, the *Professional Standards for Teaching Mathematics* (NCTM, 1991) established
mathematical task criteria to guide the course designer and teacher in the
development of course assessments.

3. **Opportunity-to-learn** standards define how administrators, staff, and
teachers facilitate students to meet the first two standards. Opportunity-to-
learn standards may determine the course requirements and how to facilitate
the student successfully completing those requirements. Course design is often
guided by these standards, as well. For example, PSSM (NCTM, 2000)
established specific principles that serve as guidelines for the development of
quality mathematics instruction.

One focus of this study is to examine standards that define the best course design
to facilitate a student’s opportunity-to-learn in an Algebra I e-learning environment.
Consequently, this study summarizes the principles that support reformed-based
mathematics and evaluates the NCTM’s Algebra I standards against the objectives stated
within the e-learning Algebra I course case study. These objectives should align with the
PSSM to ensure that students receiving algebra instruction via e-learning have equal
access to the same benefits received by students attending brick-and-mortar schools. To
begin this process, this section reviews reform-based mathematics, best practices in
mathematics instruction, and the specific 9th-12th grade algebra standards and suggested
pedagogy. The discussion then suggests an evaluation model that assesses pedagogy and
course design for Algebra I courses, which also addresses the complex issues associated
with at-risk students and incorporates mathematics pedagogy.
Reform-based Mathematics

Reform-based mathematics can be traced back to the 1980’s as a response to the failing teaching methods in mathematics and the influence of technology and new research on how mathematics is learned. In 2000, the National Council of Teachers of Mathematics developed the *Principles and Standards for School Mathematics* as a compilation of lessons learned over the previous 10 years (Lappan, 2000¶3). This document calls for reformed mathematics pedagogy to be based on the same constructivist learning theories that underlie the HPL Framework. The framework is reflected in the six principles outlined in the *Principles and Standards for School Mathematics* (NCTM, 2000¶1):

- **Equity**: Excellence in mathematics education requires equity—high expectations and strong support for students of all characteristics and backgrounds.

- **Curriculum**: A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.

- **Teaching**: Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.

- **Learning**: Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.

- **Assessment**: Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.
Technology: Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.

Learner-centered environments are supported by the Equity, Teaching, and Learning Principles that collectively call for mathematics instruction to be presented in a manner that allows every student equitable access to the content. Both the high- and low-achievers must have instruction that provides students an opportunity to learn at an appropriate pace, using relevant and motivating materials, instructional tools, and technology. Teachers should consider the student’s prior knowledge and encourage flexible and creative problem solving, supporting a student’s unique solution to a given problem (Bransford et al., 2000; NCTM, 2000; Roberts, 2006).

Knowledge-centered environments are reflected in the Teaching and Learning Principles, as well as in the Curriculum Principle. The process of learning mathematics should be the understanding of the underlying concepts, rather than a process of memorization of facts and formulas. Mathematics education should encourage students to develop their conceptual learning, which will develop their confidence in their ability to learn and to become autonomous learners willing to take risks (Bransford et al., 2000; NCTM, 2000; Roberts, 2006).

Assessment-centered environments support the teacher maintaining a zone of development in which the student learns with the support of the teacher using multiple forms of guidance and assessment. The Assessment Principle calls for the use of multiple forms of assessments that are authentic and continuous. Summative feedback, such as tests, should not be the only form of determining a student’s progress. Assessments should include formative techniques, since such descriptive feedback provides a rich
source of guidance. Students learn differently and should be assessed appropriately based on these differences and the content to be assessed (Bransford et al., 2000; NCTM, 2000; Roberts, 2006).

Finally, the use of instructional technology provides real-world tools and experiences that enhance the teaching and learning of mathematics. Both high and low technology should be incorporated to accommodate different learners’ interests and abilities. The Technology Principle supports the three basic environments, i.e., learner-centered, knowledge-centered, and assessment-centered, since technology has the potential to enhance or adapt instructional materials and assessment to accommodate a variety of learners and their abilities (Bransford et al., 2000; NCTM, 2000; Roberts, 2006).

These principles are supported by an earlier document, the *Professional Standards for Teaching Mathematics* (NCTM, 1991), which outlines specific criteria for the mathematical tasks given to students by their teachers. These criteria focus on ensuring the tasks reflect sound mathematics; the student’s understanding, interests, and experience; and the varying ways of knowing that reflect a diverse student population. In addition, these tasks contain sub-tasks that include engaging students to develop their mathematical understanding and skills, so that they are able to make connections and develop their personal framework of mathematical ideas. Tasks presented to students by their teachers should call for problem-solving and mathematical reasoning. Teachers should promote communications about mathematics as an ongoing human activity, and the development of the student’s disposition to perform mathematics (Education Alliance, 2006).
The combination of the two NCTM documents (1991, 2000) provides a scaffold to base development of a comprehensive school mathematics program. The Education Alliance (2006) established a recommended set of best practices that support reform-based mathematics instruction. This pedagogical document divides mathematics instruction into six elements, each listing supporting best practices consistent with the standards and principles of reform-based mathematics. Table 4.2 lists the Alliance’s six elements and supporting best practices in relationship to the NCTM principles.

The Education Alliance’s best practices document forms a firm foundation for an evaluation tool for general mathematics instruction. Each of the six principle areas and the task criteria correspond to the Education Alliance’s list of best practices. The Alliance also adds professional development to their list of best practices. Those practices were included under the Equity principle since teacher beliefs and ideas of mathematics influence what and how to teach mathematics. Teachers are products of their prior experience in how mathematics was taught to them and what they have learned through their educational training. To ensure all teachers possess a firm grounding in reform-based mathematics, professional development is a necessary component of mathematics course evaluation. Those teachers working with antiquated teaching methods are less likely to address the reforms designed to bring equity to mathematics instruction (Bransford et al., 2000; Education Alliance, 2006; Roberts, 2006).

PSSM and At-Risk Students

Does the PSSM (NCTM, 2000) accommodate students who are at-risk for failure? Is Education Alliance’s list of best practices applicable for at-risk students? At-risk
students may have several issues with which to contend in the mathematics classroom. Some have difficulty with the basic mathematics skills required to succeed and may require remediation. Others may lack persistence or motivation. Still others may suffer from math anxiety or possess problems with maintaining attention. General and special education teachers identified three primary advantages of the PSSM for teaching at-risk students: (1) hands-on learning, (2) real-world connections, and (3) equity (Maccini & Gagnon, 2000).

The PSSM promotes the use of hands-on learning through the use of manipulatives that stimulate conceptual understanding rather than rote memorization. The manipulatives provide teachers a means by which to reach students who are auditory or visual learners. Technology-enhanced instruction may provide the immediate feedback a student requires to self-analyze his understanding and make adjustments (Akst, 1998; Hilton, 1980; Maccini & Gagnon, 2000; Zbiek, 1998).

Higher-order reasoning and critical thinking skills and activities are emphasized to promote students making connections to real-world applications. Real-world activities help to reach the students who need that extra motivation to stay on task. Computer-enhanced instruction may be able to bring real-world applications directly into the classroom and have the added benefit of providing semantic feedback for students to take appropriate corrective action (Akst, 1998; Akiba, 2002; Connell, 1995; Dalton, 1998; Hilton, 1980; Maccini & Gagnon, 2000, Zbiek, 1998).

The promotion of equity in curriculum calls for all students to be exposed to comparable curriculum and opportunities to learn and advance. Teachers note that adaptations and provisions may be necessary to accommodate student special needs. The
most popular adaptation was the use of calculators to eliminate tedious calculations, which leaves that student frustrated, unmotivated, and rushed. Calculators allow the student to focus on concepts, they may help to reduce anxiety in the process, and encourage students to self-correct their work (Akst, 1998; Deshler, Ellis, & Lenz, 1996; Maccini & Gagnon, 2000; Meece, 1994).

Both the PSSM and Education Alliance’s best practices effectively address the needs of at-risk students, if teachers and course designers heed the call. However, teachers note that other adaptations have proven helpful and should be considered when teaching mathematics to at-risk students, such as

- Increasing the allotted time for activities and tests,
- Dividing assignments into smaller chunks,
- Encouraging cooperative group work,
- Reducing the amount of copying required for notes,
- Providing small group instruction,
- Forming mixed-ability groupings, and
- Exercising frequent repetition and review (Bezuk & Cegelka, 1995; Dalton, 1998; Englert, 2002; Meece, 1994).

These pedagogical additions are in keeping with the vision of both NCTM and the Education Alliance. However, in building an evaluation tool that will accommodate at-risk students in the mathematics classroom it is necessary to use these proven instructional adaptations where appropriate.
Table 4.2: Relationship of the PSSM (NCTM, 2000), the Mathematics Task Criteria (NCTM, 1991), and the Education Alliance Best Practices (2006)

|--------------------|----------------------------------------|------------------------------------------|----------------------------------------|
| Equity             | Knowledge of the range of ways diverse students learn mathematics | • Engage students’ intellect  
                        • Develop students’ mathematical understandings and skills  
                        • Stimulate students to make connections and develop a coherent framework for mathematical ideas  
                        • Call for problem formulation, problem solving, and mathematical reasoning  
                        • Promote communication about mathematics  
                        • Represent mathematics as an ongoing human activity  
                        • Display sensitivity to, and draw on, students’ diverse background experiences and dispositions  
                        • Promote the development of all students’ dispositions to do mathematics (NCTM, 1991, p. 25) | • Have professional development  
                            • Understanding/using standards  
                            • Using best practices  
                            • Developing/providing support materials  
                            • Using multiple assessments  
                            • Establish mathematics leadership teams  
                            • Differentiate instruction  
                            • Build on prior experience/knowledge  
                            • Include real-life connections  |
| Curriculum         | Knowledge of the range of ways diverse students learn mathematics | • Use challenging content  
                        • Use standards-based curriculum  
                        • Identify skills/concepts/knowledge to be mastered  
                        • Ensure curriculum is vertically & horizontally articulated | • Use standards-based lessons  
                        • Differentiate instruction  
                        • Use learner-centered activities  
                        • Emphasize inquiry/problem-solving  
                        • Include real-life connections  
                        • Use cooperative learning  
                        • Build on prior experience/knowledge  
                        • Emphasize basic computational skills  
                        • Use probing questions that require a justification from the student  
                        • Scaffold to make connections |
| Teaching           | Knowledge of the range of ways diverse students learn mathematics | • Sound & significant mathematics  
                        • Knowledge of the range of ways diverse students learn mathematics (NCTM, 1991, p. 25) |                                      |
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<td><strong>Learning</strong></td>
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<tr>
<td></td>
<td>Use manipulatives</td>
<td>Use manipulatives</td>
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<td></td>
<td>o That are aligned with math concepts</td>
<td>o That are aligned with math concepts</td>
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<td></td>
<td>o To develop understanding</td>
<td>o To develop understanding</td>
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<td></td>
<td>o To demonstrate word problems</td>
<td>o To demonstrate word problems</td>
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<td><strong>Assessment</strong></td>
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<td>Align with the standards</td>
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<td>Student self-monitoring</td>
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<td>Evaluate both the student progress &amp;</td>
<td>Evaluate both the student progress &amp;</td>
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<td>performance, &amp; the teacher effectiveness</td>
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<td>Use both traditional &amp; alternative strategies</td>
<td>Use both traditional &amp; alternative strategies</td>
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<td>Use open-ended techniques</td>
<td>Use open-ended techniques</td>
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<td>Include diagnostic, formative, &amp; summative strategies</td>
<td>Include diagnostic, formative, &amp; summative strategies</td>
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<td>Conduct error analysis of student work</td>
<td>Conduct error analysis of student work</td>
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<td>Provide guided practice with feedback</td>
<td>Provide guided practice with feedback</td>
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<tr>
<td><strong>Technology</strong></td>
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<td></td>
<td>Integrate technology across the curriculum</td>
<td>Integrate technology across the curriculum</td>
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<td>Use &amp; provide access to instructional technology tools (i.e., computer manipulatives, graphic calculators, &amp; software)</td>
<td>Use &amp; provide access to instructional technology tools (i.e., computer manipulatives, graphic calculators, &amp; software)</td>
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</tbody>
</table>

- **Learning**
  - Engage students’ intellect
  - Develop students’ mathematical understandings and skills
  - Stimulate students to make connections and develop a coherent framework for mathematical ideas
  - Call for problem formulation, problem solving, and mathematical reasoning
  - Promote communication about mathematics
  - Represent mathematics as an ongoing human activity
  - Display sensitivity to, and draw on, students’ diverse background experiences and dispositions
  - Promote the development of all students’ dispositions to do mathematics (NCTM, 1991, p. 25)

- **Assessment**
  - Sound & significant mathematics
  - Knowledge of the range of ways diverse students learn mathematics
  - Knowledge of the range of ways that diverse students learn mathematics (NCTM, 1991, p. 25)

- **Technology**
  - Engage students’ intellect
  - Develop students’ mathematical understandings and skills
  - Stimulate students to make connections and develop a coherent framework for mathematical ideas
  - Call for problem formulation, problem solving, and mathematical reasoning
  - Promote communication about mathematics
  - Represent mathematics as an ongoing human activity
  - Display sensitivity to, and draw on, students’ diverse background experiences and dispositions
  - Promote the development of all students’ dispositions to do mathematics (NCTM, 1991, p. 25)
Until recently, algebra was a subject focused on solving equations using problems based on artificial mathematical applications, rather than rich real-world applications. Algebra was taught as a compilation of the skills needed to solve equations, manipulate symbolic expressions, and solve word problems (NTCM, 1999). As such, algebra has historically been a struggle for at-risk students, such as poor, female, and minority students. The socioeconomic status (SES) of minority students influences whether they enroll in algebra courses. Students from low SES homes or representing a minority have more difficulties with algebra than their white counterparts from high SES homes. As a powerful gatekeeper for higher mathematics in high school, success in college, and, some say, to “full citizenship” (Checkley, p. 6), a key element to mathematics reform must be to increase the algebra proficiency of all of our K-12 students and make algebra a defining benchmark for mathematical literacy (Confrey, 1998; Johnson & Kritsonis, 2006; McCoy, 2005; Moses & Cobb, 2001; Paul, 2005; Singh & Granville, 1999).

Masini (2001) reported that although low-SES white and minority students received the same instruction in a variety of algebra-related topics in eighth grade, high-SES white students received significantly more algebra-related instruction in eighth grade than high-SES minority students. This difference is attributed to the continued practice of tracking minority students into less challenging coursework (Checkley, 2001; McCoy, 2005). Teacher expectations, which are often much lower for minority students, may also contribute to these results. Many minority students are simply not receiving the instructional practices in algebra that are recommended in the PSSM (Johnson & Kritsonis, 2006). Just as the PSSM calls for mathematics content to be centered on real-world problem-solving and reasoning, so should
the instruction of algebra. Embedding algebra concepts in contextual settings help students make a connection to the concepts. Teachers must embrace the fact that algebra is used on a regular basis in our lives and as such, instruction of algebra should extend beyond the routines and manipulation of symbols (National Academy of Sciences, 1998).

Whether one realizes it or not, determining gas mileage, predicting the amount of food to prepare for a party, and figuring the cost of renting videos are all examples of daily situations steeped in algebra and requiring a certain level of algebraic understanding. (Williams & Molina, 1999, p. 41)

Teachers must also move away from restricting students to only one way to solve a problem, with the solution considered explicitly right or wrong, to empowering students to discover multiple ways to solve a problem (Confrey, 1998). The classroom should be a safe community of learners that encourages discourse, conjectures, arguments, multiple strategies, and consensus. However, teaching is a balancing act that requires the teacher to prioritize teaching methods based on her specific teaching situation and students. There is no one recipe that is the ultimate solution for all students. A recent meta-analysis (Hass, 2005) of 35 independent experimental studies that compared instructional methods to achievement resulted in the recommendation of three basic teaching methods for consideration when teaching high school algebra:

1. **Direct Instruction**: Provide timely reinforcement and written feedback; deliver specific comments to students to help those self-identify incorrect thinking patterns; and introduce and review sequential concept instruction from concrete to abstract.

2. **Problem-based Learning**: Provide inquiry-based instruction that includes the student generating hypotheses and alternate solutions; relate concepts to real-life
situations; use open-ended projects; and emphasize the process rather than the solution.

3. **Manipulatives, Models, and Multiple Representations**: Provide illustrations of concepts using pictures; provide games and simulations for students to use for practice; encourage students to use graphic representations, physical models, physical and mental pictures, and tables and diagrams to represent problems and solutions.

The Technology Principle states that technology is essential to the instruction and learning of mathematics (NCTM, 2000). The Hass (2000) meta-analysis supports NCTM’s emphasis on the integration of technology into the mathematics classroom. Although the effect size was less than other methodologies, technology tools, such as computational and graphing calculators, computer-generated spreadsheets, and computer software provided opportunities for students to practice algebraic skills and to visualize concepts. Technology has the potential to reduce the amount of time required for a student to develop her conceptual understanding and the reasoning that is the essence of mathematical problem solving (Van de Walle, 1998; Wiest, 2001). Instructional software, such as tutorials, games, simulations, and computer algebra systems (CAS) allow the student to experience different situations that enable them to visualize mathematics relationships and test hypotheses (Brooks, 1999). Virtual manipulations and representations via computer software and the Internet are adaptable and as such are able to differentiate instruction to meet the needs of a diverse student population (Cannon, Heal, & Dorward, 2002; Harvey, Waits, & Demana, 1995). In addition, mathematical representation via a virtual environment provides the student with multiple opportunities to attempt to solve a given mathematical task, with the
added benefit of hints and alternate teaching approaches generated specifically in response to the student’s proposed solutions (Dunn, 2002). The use of technology-aided instruction offers the student an additional layer of flexibility that may lead to a deeper level of understanding than might not otherwise occur without technology (Confrey, 1998; Van de Walle, 1998; Wiest, 2001).

The study of algebra is not considered a one or two course phenomenon; rather algebra is considered best studied throughout a student’s entire K-12 educational experience (NCTM, 2000). However, benchmarks for each grade level are set to guide what and when a student should reach specific competencies in algebra. Table 4.3 outlines what an eighth grade student should be able to accomplish in algebra prior to entering ninth grade. Close evaluation of this standard reveals that the required tasks of an eighth grade student represents the content typically presented in an Algebra I course, whether it is offered in eighth grade or ninth grade (J. Yow, personal communication, 2007). Therefore, this set of algebra tasks will be the content standard upon which this study will focus.

Algebra should be learned over the course of a K-12 student’s educational career. Consequently, the tasks represented in Table 4.3 are not divided into specific semester content as would be expected in a stand-alone algebra course.

Figure 4.8 represents a framework developed by Kleiman (1998) that corresponds to the content for a first year algebra course. The light grey components represent content that may be presented in the first semester and the dark grey components represent content reserved for the second semester. The framework also demonstrates the triangular relationship between the various situations, mathematical representations, and mathematical findings that define algebra and models the process by which a solution to an algebraic
problem may be developed. The process begins with extracting information from the situation and forming a mathematical representation (e.g., graphs or tables) of the situation. Situation types include real-world data, stories with a mathematical foundation, physical experiments (e.g., science experiments); physical or pictorial arrangements, general mathematics problems, or games, puzzles, or simulations.

Table 4.3: PSSM (NCTM, 2000, p.222) Overview of Grade 6-8 Algebra Standards

<table>
<thead>
<tr>
<th>Algebra I Standard$^7$</th>
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| Understand patterns, relations, and functions | - represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules;  
- relate and compare different forms of representation for a relationship;  
- identify functions as linear or nonlinear and contrast their properties from tables, graphs, or equations. |
| Represent and analyze mathematical situations and structures using algebraic symbols | - develop an initial conceptual understanding of different uses of variables;  
- explore relationships between symbolic expressions and graphs of lines, paying particular attention to the meaning of intercept and slope;  
- use symbolic algebra to represent situations and to solve problems, especially those that involve linear relationships;  
- recognize and generate equivalent forms for simple algebraic expressions and solve linear equations. |
| Use mathematical models to represent and understand quantitative relationships | - model and solve contextualized problems using various representations, such as graphs, tables, and equations. |
| Analyze change in various contexts | - use graphs to analyze the nature of changes in quantities in linear relationships. |

Mathematical analyses are performed and the findings are interpreted and applied back to the situation from the mathematical form. Students should ultimately be expected to

$^7$ This standard is the Algebra Standard for grades 6-8 as detailed in the PSSM. This represents the algebra content to be learned by the end of 8th grade. For many students some or all of this content is addressed in an Algebra I course typically taken in grade 8 or 9.
apply their solutions to predict solutions in new situations using their understanding of a repertoire of mathematical tools and patterns.

Adding the PSSM algebra content standards to Table 4.3, a complete evaluation tool is created that may be used to evaluate the content and the pedagogical best practices for an Algebra I course (see Table 4.4). This tool will be the foundation for evaluating an online Algebra I course in terms of mathematics pedagogy and the recommended algebra content. In addition to evaluating the mathematics pedagogy, an evaluation tool for an e-learning course must also address the specific learning environment and the pedagogy required to adapt a course to an e-learning structure. While the guidelines for pedagogy and course design of the traditional classroom can serve as a beginning point for developing an equivalent online course, those guidelines are insufficient to be the sole foundation of the development and implementation of an e-learning course.

This section tied together the PSSM with the How People Learn Framework and the underlying learning theories and theoretical constructs from Chapter Three. In addition, the PSSM was compared with the Education Alliance’s Best Practices for Mathematics to form the Algebra I Evaluation Tool, which may be used to evaluate a traditional Algebra I course. The next section describes the best practices for the development and delivery of an e-learning course. The Algebra I Evaluation Tool will then be enhanced by aligning it with e-learning best practices to form a comprehensive tool for evaluating Algebra I e-learning courses. This final evaluation tool is the product of merging the concepts of pedagogy, course design, learning theories and frameworks, and both mathematics and e-learning best practices and standards.
Figure 4.8: Algebra I curriculum framework adapted from Kleiman, 1998 in consultation with J. Yow, personal communication, 2007
Table 4.4: Algebra I Evaluation Tool

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Equity</td>
<td>• have professional development</td>
<td>Understand patterns, relations, and functions</td>
</tr>
<tr>
<td></td>
<td>o understanding/using standards</td>
<td>• represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules;</td>
</tr>
<tr>
<td></td>
<td>o using best practices</td>
<td>• relate and compare different forms of representation for a relationship;</td>
</tr>
<tr>
<td></td>
<td>o developing/providing support materials</td>
<td>• identify functions as linear or nonlinear and contrast their properties from tables, graphs, or equations.</td>
</tr>
<tr>
<td></td>
<td>o using multiple assessments</td>
<td>Represent and analyze mathematical situations and structures using algebraic symbols</td>
</tr>
<tr>
<td></td>
<td>o establish mathematics leadership teams</td>
<td>• develop an initial conceptual understanding of different uses of variables;</td>
</tr>
<tr>
<td></td>
<td>• differentiate instruction</td>
<td>• explore relationships between symbolic expressions and graphs of lines, paying particular attention to the meaning of intercept and slope;</td>
</tr>
<tr>
<td></td>
<td>• build on prior experience/knowledge</td>
<td>• use symbolic algebra to represent situations and to solve problems, especially those that involve linear relationships;</td>
</tr>
<tr>
<td></td>
<td>• include real-life connections</td>
<td>• recognize and generate equivalent forms for simple algebraic expressions and solve linear equations</td>
</tr>
<tr>
<td>Curriculum</td>
<td>• use challenging content</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• use standards-based curriculum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• identify skills/concepts/knowledge to be mastered</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• ensure curriculum is vertically &amp; horizontally articulated</td>
<td></td>
</tr>
<tr>
<td>Teaching</td>
<td>• use standards-based lessons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• differentiate instruction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• use learner-centered activities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• emphasize inquiry/problem-solving</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• include real-life connections</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• use cooperative learning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• build on prior experience/knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• emphasize basic computational skills</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• use probing questions that require a justification from the student</td>
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</tr>
<tr>
<td></td>
<td>• scaffold to make connections</td>
<td></td>
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<td>-------------------</td>
<td>------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td><strong>Learning</strong></td>
<td>• use manipulatives</td>
<td>Use mathematical models to represent and understand quantitative relationships</td>
</tr>
<tr>
<td></td>
<td>▪ that are aligned with math concepts</td>
<td>• model and solve contextualized problems using various representations, such as graphs, tables, and equations.</td>
</tr>
<tr>
<td></td>
<td>▪ to develop understanding</td>
<td><strong>Analyze change in various contexts</strong></td>
</tr>
<tr>
<td></td>
<td>▪ to demonstrate word problems</td>
<td>• use graphs to analyze the nature of changes in quantities in linear relationships.</td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
<td>• align with the standards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ student self-monitoring</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ evaluate both the student progress &amp; performance, &amp; the teacher effectiveness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• use both traditional &amp; alternative strategies</td>
<td></td>
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<tr>
<td></td>
<td>• use open-ended techniques</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• include diagnostic, formative, &amp; summative strategies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• conduct error analysis of student work</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• provide guided practice with feedback</td>
<td></td>
</tr>
<tr>
<td><strong>Technology</strong></td>
<td>• integrate technology across the curriculum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• use &amp; provide access to instructional technology tools (i.e., computer manipulatives, &amp; graphic calculators &amp; software)</td>
<td></td>
</tr>
</tbody>
</table>
e-Learning Standards and Evaluation

The ADDIE model requires that evaluation must be a key component in the development of any course. Moore & Kearsley (1996) agree that evaluation must always be an essential component for the development of an online course. However, the evaluation process would be more effective if there was a framework from which to make decisions about the quality of the course design. Chao, Saj, and Tessier (2006) proposed a quality framework to serve as a blueprint for the systematic evaluation of web-based courses. The framework includes six interconnected components (see Figure 4.9). If an evaluation of a course is missing a piece of the puzzle then the full picture of the course is missing.

Figure 4.9: Quality Framework for Web-based Courses (Chao et al., 2006)

The evaluative questions associated with each component are as follows:

- **Curriculum Design**: Are the content specific learning outcomes incorporated, aligned with standards, and clearly understood?
- **Instructional Design**: Is there an appropriate connection between the learning outcomes, activities, teaching strategies, and technology?
• **Web Design**: How does the usability of the web design affect how the learners interact with the web content, the teacher and other students?

• **Teaching and Facilitation**: How well does the instructor facilitate student learning within a web-based course?

• **Learning Experience**: How do the students’ prerequisite knowledge, learning styles, and the dynamics of the course interaction affect the students’ learning experience?

• **Course Presentation**: What is the course presentation in terms of professionalism, functionality, consistency, and look and feel?

Each component is equally important. An evaluation lacking consideration for one of the components fails to complete the puzzle and does not provide a full assessment of the course quality.

Implementing this framework to develop an evaluation model requires the identification of what is already known that plays a role in building a quality course and then determining what is missing, in part or in whole. Figure 4.10 identifies components of the Algebra I Evaluation Tool that corresponds to the Chao et al. (2006) *Quality Framework for Web-based Courses*. Of the six components of the Quality Framework, several evaluation criteria from the Algebra I Evaluation Tool correspond to the framework. The NCTM content standards should be present in the curriculum design of a web-based Algebra I course. The instructional design should include mathematics instructional practices such as: the use of manipulatives and technology, differentiated instruction, real-life connections, and formative feedback. Teaching and facilitation, as well as the learning experience, includes strategies such as learner-centered and
cooperative learning activities. The teacher is encouraged to emphasize inquiry, to scaffold student learning, infuse technology, and use alternative assessments as well (Educational Alliance, 2006; NCTM, 2000).

The Quality Framework’s web design and course presentation components are not addressed by the NCTM standards, so standards specific to web-based courses must be applied to these portions of the framework that are recommended by other organizations with specialization or expertise in e-learning courses. Founded in 2003, the North American Council for Online Learning’s (NACOL) mission “is to increase educational opportunities and enhance learning by providing collegial expertise and leadership in K-12 online teaching and learning” (NACOL[1]). NACOL is widely recognized as the national and international source for information and policies about K-12 virtual schools and as such, has recommended several guidelines for the purpose of evaluating K-12 virtual school curriculum and course design. Two organizations recommended by NACOL have been in the forefront of developing standards and policies for virtual high schools, the National Education Association (NEA) and the Southern Regional Education Board (SREB). Both the NEA and the SREB have significant stakes in the quality of virtual schools since these organizations represent the interests of the public schools and their teachers, which include any public online school program. Therefore, this study chose to use the standards and guidelines of these key organizations as the foundation for developing a single evaluation model for public online courses.
Figure 4.10: Corresponding components of the Algebra I Evaluation Tool and the Quality Framework for Web-based Courses by Chao et al. (2006)
NEA published two documents to guide stakeholders concerned with the development and quality of virtual school courses.


The *Guide to Online High School Courses* provides a series of checklists for policymakers, online teachers, and for managers and administrators of online courses. The guide is in the form of a rubric with a score range of one to four, with one indicating “not evident” and four indicating “fully evident.” There are seven top-level evaluation criteria:

1. **Curriculum:** Should be challenging, relevant, and aligned with state, national, and/or district standards.

2. **Instructional Design:** Should be informed by learning theory research and take advantage of the special online circumstances, and support the development of 21st century learning skills.

3. **Teacher Quality:** Should be knowledgeable of the subject matter, learning theories, technologies, and pedagogies appropriate for an online environment.

4. **Student Roles:** Should be actively engaged in the learning process and interact with the teacher and other students regularly.

5. **Assessment:** Should be authentic, formative, and regular. Should provide students opportunity to reflect on their learning and quality of work. End-of-course assessments should allow the student to demonstrate skills and understanding of the course content.
6. **Management and Support Systems**: Should ensure effective student and school participation. Should provide resources of all stakeholders.

7. **Technological Infrastructure**: Should provide the necessary tools for instruction and interactivity within the course and provide technological support for software and hardware.

The teacher quality criteria were expanded by the NEA in their *Guide to Teaching Online Courses* to include nineteen skills online teachers should be expected to demonstrate. NEA recommends that all online teachers should demonstrate competency in each of these skills and that all administrators of online schools should know how to evaluate teachers based on these guidelines. These skills can be grouped into three primary categories:

1. **Online Teaching Skills and Delivery**: Fostering student-to-student and teacher-to-student interaction, communication, and collaboration, providing timely feedback, revising and providing course materials when appropriate and in a timely manner.

2. **Technology and Design Skills**: Understanding the language of online education, using computer management systems (CMS) for course design that adheres to online and content standards, and providing basic technical support to students.

3. **Communication and Management**: Communicating with students, parents, school officials, and other teachers and keeping track of student participation and enrollment status.
The NEA calls for a “robust professional development program” (NEA, 2002, p. 11). A good traditional teacher is not always a good online teacher, especially if they have not received adequate training in this new learning paradigm (Davis & Roblyer, 2005). Those online virtual school teachers that do receive training often receive it as in-house professional development and do attend specialized training or certification programs outside of their own district, which may provide a greater understanding of the theoretical and practical understanding of online teaching. Some virtual school programs have developed extensive training programs for teachers wishing to enter the virtual high school environment. For example, the Virtual High School in Maynard, Massachusetts offers two such programs: (1) the Teaching Learning Conference, and (2) the Netcourse Instructional Methodologies. The Teaching Learning Conference is conducted over 22 weeks and offers 12 graduate credits. The Netcourse Instructional Methodologies course is conducted over 10 weeks and offers six graduate credits (Virtual High School, n.d.b). Another program, the Teacher Education Goes Into Virtual Schooling (TEGIVS) integrates virtual schooling curriculum into preservice teacher education programs at four U.S. universities with the goal of providing a model for “how to prepare teachers and support staff who are both comfortable and competent with ‘the schools that technology built [virtual schools]’” (Davis & Roblyer, 2005, p. 407). In other words, the goal of this program is to prepare preservice teachers to competently teach K-12 distance education. This study supports these efforts and suggests that all online K-12 teachers should complete training that goes beyond school-based professional development that may or may not be extensive enough to produce an effective online teacher.
SREB represents sixteen states within the southern region of the United States. The board is a non-profit educational organization that works with state leaders and policy-makers to improve pre-K through postsecondary education. SREB has several publications concerning the quality of virtual schools. Of those publications, two provide evaluation rubrics for states and schools to use when reviewing their virtual schools.


2. *The Online Teaching Evaluation for State Virtual Schools* (SREB, 2006b)

The *Checklist for Evaluating Online Courses* is in the form of a rubric with a score range of one to three, with one indicating “meets criteria” and three indicating “does not meet criteria.” There are five top-level evaluation criteria:

1. **Content**: Evaluates the content standards and assessments, the overview and introduction, the legal and acceptable use policies, and the teacher resources.

2. **Instructional Design**: Evaluates the instructional and audience analysis, course units and lesson designs, goals and objectives, instructional strategies and activities, communication and interaction, and resources and materials.

3. **Student Assessment**: Evaluates the assessment strategies, the methods and procedures, the feedback, and the assessment resources and materials.

4. **Technology**: Evaluates the course architecture, user interface, technology requirements and interoperability, accessibility, and technical support.

5. **Course Evaluation and Management**: Evaluates the course effectiveness, updating the course, accreditation, and data security.
The Online Teaching Evaluation for State Virtual Schools consists of three top-level criteria formed from eleven standards. The scoring consisting of only “meets standard” or “does not meet standard.” The three criteria are:

1. **Academic Preparation**: Evaluates the teacher’s academic credentials.

2. **Content Knowledge and Skills for Instructional Technology**: Evaluates the teacher’s technology skills.

3. **Online Teaching and Learning Methodology, Management, Knowledge, Skills, and Delivery**: Evaluates the teacher’s experience learning online, the teacher’s plans, designs, and strategies, and feedback and responses. Evaluates if the teacher models, guides, and encourages appropriate behavior, as well as the teacher’s assignments and assessments.

### Quality Framework

- **Web Design**
  - How does the usability of the web design affect how the learners interact with the web content, the teacher and the other students?

- **Course Presentation**
  - What is the course presentation in terms of professionalism, functionality, consistency, and look and feel?

### NEA and SREB Course Guidelines

- **NEA Technological Infrastructure**: should provide the necessary tools for instruction and interactivity within the course and provide technological support for software and hardware.

- **SREB technology**: evaluates the course architecture, user interface, technology requirements and interoperability, accessibility, and technical support.

- **NEA Management and Support Systems**: should ensure effective student and school participation. should provide resources of all stakeholders.

- **SREB Course Evaluation and Management**: evaluates the course effectiveness, updating the course, accreditation, and data security.
Figure 4.11: NEA and SREB Guidelines in terms of the Quality Framework

**Quality Framework**

**Curriculum Design**
Are the content specific learning outcomes incorporated, aligned with standards, and clearly understood?

**Instructional Design**
Is there an appropriate connection between the learning outcomes, activities, teaching strategies, & technology?

**Teaching & Facilitation**
How well does the instructor facilitate student learning within a web-based course?

**Learning Experience**
How do the students’ prerequisite knowledge, learning styles, and dynamics of the course interaction affect the students’ learning experience?

**NEA and SREB Course Guidelines**

- **NEA Curriculum**: Should be challenging, relevant, and aligned with state, national, and/or district standards.
- **SREB Content**: Evaluates the content standards and assessments, the overview and introduction, the legal and acceptable use policies, and the teacher resources.

- **NEA Instructional Design**: Should be informed by learning theory research and take advantage of the special online circumstances, and support the development of 21st century learning skills.
- **SREB Instructional Design**: Evaluates the instructional and audience analysis, course units and lesson designs, goals and objectives, instructional strategies and activities, communication and interaction, and resources and materials.

- **NEA Teacher Quality**: Should be knowledgeable of the subject matter, learning theories, technologies, and pedagogies appropriate for an online environment.
- **NEA Student Roles**: Should be actively engaged in the learning process and interact with the teacher and other students regularly.
- **SREB**: Not applicable

- **NEA Assessment**: Should be authentic, formative, and regular. Should provide students opportunity to reflect on their learning and quality of work. End-of-course assessments should allow the student to demonstrate skills and understanding of the course content.
- **SREB Student Assessment**: Evaluates the assessment strategies, the methods and procedures, the feedback, and the assessment resources and materials.
The NEA and SREB online course guidelines correspond to the Quality Framework’s web design and course presentation components. The web design should provide tools that enhance instruction and promote interactivity, ensure interoperability between the different technologies required by the course, and provide easy user access and navigation. Although a professional appearance is important, what is most important is that the course supports effective instruction and participation, and ensures privacy for the students. Figure 4.11 identifies the components of the NEA and SREB course guidelines in terms of the Quality Framework for Web-based Courses.

Table 4.5 represents the e-Learning Evaluation Tool for Algebra I Courses (e-LETAC) developed by blending of the standards and guidelines recommended by the National Council for Teachers of Mathematics, the Education Alliance, the National Education Association, and Southern Regional Education Board into one comprehensive evaluation model. This evaluation tool accounts for the standards and principles set forth by NCTM for both the expectations in algebra content and recommended mathematics pedagogy, which are supported by Education Alliance’s recommended best practices. The evaluation tool also blends the guidelines and recommended evaluation criteria for online courses set by the NEA and SREB. In addition, the model expands upon the Quality Framework for Web-based Courses by Chao et al. (2006). The Quality Framework provides only a blueprint of the key components necessary to evaluate a web-based course fully. The framework lacks the details required to conduct a comprehensive analysis of a content-specific online course.

The e-LETAC tool is in the form of a chart with five columns devoted to a different aspect of an evaluation. The first and second columns represent the top-level
quality criteria and the corresponding sub-criteria. The three top-level quality criteria and evaluation questions that one associates with the criteria are:

1. **Teacher Quality**: What is the teacher’s academic preparation? How prepared and organized is the teacher? Does the teacher monitor student progress and how? What are the teacher’s technology skills? Can the teacher provide technical support? How well does the teacher facilitate online instruction and interaction? What assignments, activities, and assessments does the teacher use?

2. **Instructional Design**: Has the design process followed the ADDIE model or other ISD model? Has an instructional and audience analysis been conducted? Does the course and design meet school or district credit requirements? Do the instructional strategies and materials reflect the objectives and skills of the course content? How well are the selected media enhancing the learning process? Is the course learner-centered and user-friendly? Are the technology and instructional materials provided to the student, and tested and validated? Is the content aligned with the established standards? Is the course evaluated regularly and is that evaluation shared with the teacher?

3. **Support Systems Quality**: Is professional development opportunities available to the teachers and designers? Is there an orientation for students and parents? Are counselors present and accessible to both the students and the parents? Are course facilitators provided? Are teacher and student resources available and easily accessed? Is the technology infrastructure adequate and is regular support provided to resolve technical problems?
The third column contains content and pedagogical standards specific to algebra content and instruction at the eighth to ninth grade level, as recommended by NCTM (2000) and the Education Alliance (2006). Each criterion, which in the e-LETAC is referred to as an indicator, was assigned a number. The fourth column lists the numbers that correspond to each indicator. The fifth column was the scoring area. There are three levels of performance represented by numbers, shown below. Zero was assigned if it was not possible to observe the indicator or information was unavailable to score the indicator. Indicators receiving a zero were not included in the final total score or calculation of the average score.

- **0** = information unavailable or unobservable
- **1** = does not meet the indicator
- **2** = partially meets the indicator, but needs some improvement
- **3** = meets the indicator, no improvements obvious

In this first iteration of the e-LETAC tool, there is no rubric to define the performance levels.

The fifth column provides space for noting comments and recommendations that would otherwise be available through a comprehensive rubric. This also serves as an area to note if there was not enough information to evaluate if a specific criteria was met.

Although the e-LETAC tool was developed with Algebra I courses as the target content area, the tool is easily adapted for any content area. To adapt the tool for another content area, one would simply replace the Algebra I Evaluation Tool in the third column with the standards and pedagogy recommended for the new content area.
Table 4.5: *e-Learning Evaluation Tool for Algebra I Courses (e-LETAC)*

1 = does not meet the indicator  
2 = partially meets the indicator, but needs some improvement  
3 = meets the indicator, no improvements obvious

<table>
<thead>
<tr>
<th>Teacher Quality Criteria</th>
<th>NEA &amp; SREB Indicators</th>
<th>Algebra I Evaluation Tool (Standards/Pedagogy)</th>
<th>Q#</th>
<th>$</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Preparation</td>
<td>1. Meets state licensing requirements in the field she is teaching.</td>
<td>7. State Licensed 9-12 Mathematics teacher or National Board Certified in Mathematics in Adolescence or Young Adulthood (3)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Familiar with state and national standards and curriculum for the subject she/he is teaching.</td>
<td></td>
<td>2</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>3. Has completed professional development training in online teaching strategies and has first hand experience as an online student.</td>
<td></td>
<td>3</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>4. Attends professional development sessions to improve old or learn new teaching strategies.</td>
<td></td>
<td>4</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>5. Maintains a reflective approach to teaching and is open to changes.</td>
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<td>5</td>
<td></td>
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<tr>
<td></td>
<td>6. Self-evaluates teaching and course structure, presentation, and documents.</td>
<td></td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. State Licensed 9-12 Mathematics teacher or National Board Certified in Mathematics in Adolescence or Young Adulthood (3)</td>
<td></td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preparation and Organization</td>
<td>8. Teacher prepared course materials are uploaded in advance of the course start date.</td>
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<td>8</td>
<td></td>
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<tr>
<td></td>
<td>9. Reviews student records to understand the student’s prior academic experiences &amp; ability levels.</td>
<td></td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10. Provides syllabus with goals, objectives, expectations, assignments, and assessments, including due dates and penalties.</td>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Progress</td>
<td>11. Guides students in time management skills.</td>
<td></td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring</td>
<td>12. Establishes expectations for response times for instructor/student, and student/student electronic communications.</td>
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<td>12</td>
<td></td>
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<tr>
<td></td>
<td>13. Developed monitoring system for student interaction and academic progress.</td>
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<td>13</td>
<td></td>
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<tr>
<td></td>
<td>14. Contacts both the student and parents when issues arise.</td>
<td></td>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1 = does not meet the indicator       2 = partially meets the indicator, but needs some improvement       3 = meets the indicator, no improvements obvious

<table>
<thead>
<tr>
<th>Teacher Quality Criteria</th>
<th>NEA &amp; SREB Indicators</th>
<th>Algebra I Evaluation Tool (Standards/Pedagogy)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology Skills</strong></td>
<td>15. Effectively uses basic software, the Internet, &amp; email effectively.</td>
<td>Q#</td>
</tr>
<tr>
<td></td>
<td>16. Demonstrates ability to develop and modify content and assessments in a Learning Management system (LMS).</td>
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<td></td>
<td>17. Understands technology as a tool to enhance learning.</td>
<td>Comments</td>
</tr>
<tr>
<td></td>
<td>18. Integrate technology across the curriculum</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>19. Use &amp; provide access to instructional technology tools (i.e., computer manipulatives, &amp; graphic calculators &amp; software)</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>20. Technology Policies and Support</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>21. Intervene if inappropriate behavior develops.</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>22. Troubleshoots very basic technology problems.</td>
<td>19</td>
</tr>
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<td></td>
<td>23. Assists the student in receiving help from the tech support team.</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>24. Online Facilitation Techniques</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>25. Utilizes strategies that are consistent with national content and teaching standards.</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>26. Differentiates instruction to meet the needs of her students and respect her students’ prior knowledge, experience, and culture.</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>27. Supports inquiry, problem-solving, and consensus building.</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>28. Utilizes effective teaching strategies that encourage active, interactive, participatory, and collaborative learning.</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>29. Encourages students to actively participate in course discussion, including providing constructive feedback, and group activities, including team projects.</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>30. Use standards-based lessons</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>31. Differentiate instruction</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>32. Use learner-centered activities</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>33. Include real-life connections</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>34. Use cooperative learning</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>35. Build on prior experience/knowledge</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>36. Emphasize basic computational skills</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>37. Use probing questions that require a justification from the student</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>38. Scaffold to make connections</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>39. Online Facilitation Techniques</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>40. Utilizes strategies that are consistent with national content and teaching standards.</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>41. Differentiates instruction to meet the needs of her students and respect her students’ prior knowledge, experience, and culture.</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>42. Supports inquiry, problem-solving, and consensus building.</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>43. Utilizes effective teaching strategies that encourage active, interactive, participatory, and collaborative learning.</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>44. Encourages students to actively participate in course discussion, including providing constructive feedback, and group activities, including team projects.</td>
<td>41</td>
</tr>
</tbody>
</table>
1 = does not meet the indicator  
2 = partially meets the indicator, but needs some improvement  
3 = meets the indicator, no improvements obvious

<table>
<thead>
<tr>
<th>Teacher Quality Criteria</th>
<th>NEA &amp; SREB Indicators</th>
<th>Algebra I Evaluation Tool (Standards/Pedagogy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments, Activities, &amp; Assessments</td>
<td>39. Promotes open and respectful communication with the students and the parents.</td>
<td>44. Use manipulatives</td>
</tr>
<tr>
<td></td>
<td>40. Provides multiple paths to success, including alternative and authentic assignments and assessments that are learner-centered and linked to real-world situations.</td>
<td>a. That are aligned with math concepts</td>
</tr>
<tr>
<td></td>
<td>41. Provides prompt and timely formative and summative feedback to which students have continuous access.</td>
<td>b. To develop understanding</td>
</tr>
<tr>
<td></td>
<td>42. Scoring rubrics available to students for all assignments and assessments.</td>
<td>c. To demonstrate word problems</td>
</tr>
<tr>
<td></td>
<td>43. Provides opportunities for students to self-assess their performance and progress, and encourages active ownership of the learning process.</td>
<td>d. Align with the standards</td>
</tr>
<tr>
<td></td>
<td>45. Student self-monitoring</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>46. Use both traditional &amp; alternative strategies</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>47. Use open-ended techniques</td>
<td>b</td>
</tr>
<tr>
<td></td>
<td>48. Include diagnostic, formative, &amp; summative strategies</td>
<td>c</td>
</tr>
<tr>
<td></td>
<td>49. Conduct error analysis of student work</td>
<td>d</td>
</tr>
<tr>
<td></td>
<td>50. Provide guided practice with feedback</td>
<td>44</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructional Design</th>
<th>NEA &amp; SREB Indicators</th>
<th>Algebra I Evaluation Tool (Standards/Pedagogy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional and Audience Analysis</td>
<td>51. The instructional design follows the ADDIE model or similar.</td>
<td>54. Differentiate instruction</td>
</tr>
<tr>
<td></td>
<td>52. Analysis includes and validates the course meets the school or district credit requirements.</td>
<td>55. Build on prior experience/knowledge</td>
</tr>
<tr>
<td></td>
<td>53. Instructional strategies, materials, and resources reflect the knowledge, skills, and tasks required for the learner to develop an understanding of the content.</td>
<td>56. Include real-life connections</td>
</tr>
<tr>
<td></td>
<td>54. Identify skills/concepts/knowledge to be mastered</td>
<td>57.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q#</th>
<th>S</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td></td>
<td></td>
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<tr>
<td>57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Instructional Design

<table>
<thead>
<tr>
<th>NEA &amp; SREB Indicators</th>
<th>Algebra I Evaluation Tool (Standards/Pedagogy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>58. Course structure represents a well constructed learning environment that is user-friendly and learner-centered.</td>
<td>58</td>
</tr>
<tr>
<td>59. Course is organized into units and lessons.</td>
<td>59</td>
</tr>
<tr>
<td>60. Contact information and policies are present and clear.</td>
<td>60</td>
</tr>
<tr>
<td>61. Media selected is appropriate for the learning environment and content, and enhances the learning process.</td>
<td>61</td>
</tr>
</tbody>
</table>

### Development

<table>
<thead>
<tr>
<th>NEA &amp; SREB Indicators</th>
<th>Algebra I Evaluation Tool (Standards/Pedagogy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>62. Instructional materials are created and tested prior to implementation.</td>
<td>62</td>
</tr>
<tr>
<td>63. Instructor notes and resources are created and built into the design.</td>
<td>63</td>
</tr>
<tr>
<td>64. Student resources and materials are available and designed to increase student success.</td>
<td>64</td>
</tr>
<tr>
<td>65. Multimedia enhancements are tested to ensure appropriateness and interoperability with the required technology.</td>
<td>65</td>
</tr>
<tr>
<td>66. Course supports multiple learning styles.</td>
<td>66</td>
</tr>
</tbody>
</table>

1 = does not meet the indicator  
2 = partially meets the indicator, but needs some improvement  
3 = meets the indicator, no improvements obvious
1 = does not meet the indicator  
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<table>
<thead>
<tr>
<th>Instructional Design</th>
<th>NEA &amp; SREB Indicators</th>
<th>Algebra I Evaluation Tool (Standards/Pedagogy)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Development</strong></td>
<td></td>
<td>Q#</td>
</tr>
<tr>
<td>Content</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

70. Content, objectives, goals, and assessments are aligned with national, state, and/or district content standards, and the students’ grade and skill level.

71. Understand patterns, relations, & functions
   a. represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules;
   b. relate and compare different forms of representation for a relationship;
   c. identify functions as linear or nonlinear and contrast their properties from tables, graphs, or equations.

72. Represent & analyze mathematical situations & structures using algebraic symbols
   a. develop an initial conceptual understanding of different uses of variables;
   b. explore relationships between symbolic expressions and graphs of lines, paying particular attention to the meaning of intercept and slope;
   c. use symbolic algebra to represent situations and to solve problems, especially those that involve linear relationships;
<table>
<thead>
<tr>
<th>Instructional Design</th>
<th>NEA &amp; SREB Indicators</th>
<th>Algebra I Evaluation Tool (Standards/Pedagogy)</th>
<th>Q#</th>
<th>S</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td></td>
<td>d. recognize and generate equivalent forms for simple algebraic expressions and solve linear equations</td>
<td>d</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>73. Use mathematical models to represent &amp; understand quantitative relationships. Model and solve contextualized problems using various representations, such as graphs, tables, and equations.</td>
<td>73</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>74. Analyze change in various context. Use graphs to analyze the nature of changes in quantities in linear relationships.</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implementation</td>
<td>75. Course description, with objectives and expectations, &amp; technology requirements, is available to all in advance.</td>
<td>75</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>76. Counselors are available to advise students, parents, &amp; teachers, including the enrollment process</td>
<td>76</td>
<td></td>
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<tr>
<td></td>
<td>77. Required materials are sent to students in advance.</td>
<td>77</td>
<td></td>
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<tr>
<td></td>
<td>78. Technology is tested and verified to be working in advance.</td>
<td>78</td>
<td></td>
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<tr>
<td></td>
<td>79. Introductions, user tutorials, &amp; FAQ’s are available in advance.</td>
<td>79</td>
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</tr>
</tbody>
</table>
1 = does not meet the indicator  
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<table>
<thead>
<tr>
<th>Instructional Design</th>
<th>NEA &amp; SREB Indicators</th>
<th>Algebra I Evaluation Tool (Standards/Pedagogy)</th>
<th>Q#</th>
<th>S</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **Evaluation**       | 80. Student evaluation & assessment data is collected during and after the course, and correlated to course content, delivery, & effectiveness.  
81. Student evaluations & supervisory evaluations are shared with the teacher as a tool that encourages growth and improvement.  
82. Evaluation is reviewed from both the student’s and the teacher’s perspective.  
83. All evaluations are available to the teacher for review.  
84. Revisions are made in light of the evaluation feedback using a systematic design process. | 85. Evaluate both the student progress & performance, & the teacher effectiveness | 80 |   |          |
|                      |                       |                                               | 81 |   |          |
|                      |                       |                                               | 82 |   |          |
|                      |                       |                                               | 83 |   |          |
|                      |                       |                                               | 84 |   |          |
|                      |                       |                                               | 85 |   |          |
| **Support Systems**  | 86. Teachers and the course design teams are provided professional development opportunities to improve online teaching strategies, learn new technologies that may enhance learning, and to continue to be aware of new research in the field.  
87. Orientation training is provided for third-party course software. | 88. Provide professional development  
a. Understanding/Using standards  
b. Using best practices  
c. Developing/providing support materials  
d. Using multiple assessments  
89. Establish mathematics leadership teams | 86 |   |          |
<p>|                      |                       |                                               | 87 |   |          |
|                      |                       |                                               | 88 |   |          |
|                      |                       |                                               | a  |   |          |
|                      |                       |                                               | b  |   |          |
|                      |                       |                                               | c  |   |          |
|                      |                       |                                               | d  |   |          |
|                      |                       |                                               | 89 |   |          |</p>
<table>
<thead>
<tr>
<th>Support Systems</th>
<th>NEA &amp; SREB Indicators</th>
<th>Algebra I Evaluation Tool (Standards/Pedagogy)</th>
<th>Q#</th>
<th>S</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **Student & Parent Orientation** | 90. An orientation program is provided to introduce the teachers, the students, & the parents to each other.  
91. Promotes an open and respectful communication with the students and the parents.  
92. Program includes technical training of the learning environment and the required computer skills. |                                               | 90 |   |          |
| **Counselors & Facilitators** | 93. Counselors are available to answer questions, meet with students and parents, and check in on the student’s progress.  
94. Course facilitators are available at onsite course locations and/or serve as virtual aides for the teachers. | 95. Course facilitator has completed professional development such as VHS Site Coordinator Orientation or similar | 93 |   |          |
| **Resource Availability** | 96. Teachers and students have online access to the library and other resources needed to enrich the learning process. |                                               | 96 |   |          |
| **Technology Infrastructure** | 97. The infrastructure and architecture supports interoperability, and has the capacity to support the system with limited to no down-time.  
98. Course navigation is user-friendly and meets universal design principles.  
99. The architecture supports robust multimedia content and permits the teacher to make changes to the content, activities, and assessments as needed to differentiate or extend the learning opportunities. |                                               | 97 |   |          |
| **Technology Support** | 100. The school provides required technology to the students or provides financial assistance so the students may acquire the technology.  
101. Tech support responds within 24 hours. |                                               | 100|   |          |

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Conclusion

…[E]ducation sometimes operates within a ‘transmissive paradigm’, emphasizing the transfer of knowledge from lecturer to student. This approach is not conducive to meaningful, active learning where students take a pro-active role in questioning, sharing ideas and applying prior knowledge to develop new ideas. (Luca, Cowan, & McLoughlin, 2004, p.1468)

The opinion of Luca et al. (2004) was directed at traditional higher education, but the statement is applicable to the state of K-12 education, and is often even more applicable in e-learning courses. The research demonstrates that constructivist approaches, whether applied to the traditional or the e-learning classroom, lead to richer learning experience for the student (Carr-Chellman, Dyer, & Breman, 2000; Galloway, 2001; Kilpatrick, Martin, & Schifter, 2003; Marzano, Pickering, & Pollock 2001; LaPointe & Gunawardena, 2004; Leikin & Zaslavsky, 1997; Luca, Cowan, & McLoughlin, 2004; Talvitie-Siple, 2005).

Despite the benefits, teachers are weary of implementing constructivist approaches to teaching due their sense of loosing control. This has especially been documented in mathematics classrooms where reform-based pedagogy is now the standard. Teachers, in traditional classrooms, report that implementing reform-based mathematics is often difficult. The teachers find it difficult to manage their mathematical instruction so that they are sure the students are engaged and understand the concepts correctly. They are uncomfortable with a perceived lack of control (Hufferd-Ackles, Fuson, & Sherin, 2004). If implementing the constructivist learning supported by reformed-based mathematics is difficult in the traditional classroom, how do we know if an online mathematics course will be any more successful?
Evaluation of e-learning is essential for the growth of the field in all levels, but it is especially important in virtual schools where the mission is to provide equal, but alternative educational opportunities to our K-12 students (Vrasidas, Zembylas, & Chamberlain, 2004). Dropout rates are high in our traditional schools. One significant mission of our virtual schools is to bring the traditional dropout students back into the classroom through e-learning, yet some of our virtual classrooms also suffer from high dropout rates. Others are more successful. What is responsible for the difference in success rates? Perhaps the difference lies in course design and pedagogy. The picture needs clarity. To bring clarity to the effectiveness of our virtual courses it is necessary to implement a systematic evaluation tool. Such a tool must not only evaluate the online delivery method, but also take into account the specific content standards and pedagogy that is informed by accepted learning theories and supported by the research.

Evaluation studies are of immense importance in establishing successful models for the development, delivery, and support of K-12 virtual schools so that all students are able to play well in the virtual sandbox (Roblyer, 2003; Vrasidas et al., 2003). In response, this chapter systematically developed an evaluation model for online Algebra I courses. First, the PSSM (NCTM, 2000) for effective teaching practices in the field of mathematics, as well as the content standards for Algebra in the eighth and ninth grade, were evaluated. These standards were then compared to the best practices in mathematics recommended by the Education Alliance (2006) and an evaluation tool was created for the purpose of evaluating a traditional Algebra I course. Next, the NEA and SREB guidelines for the evaluation of e-learning course design and best practices were blended with the standards and principles of mathematics, and the content of Algebra I into one
comprehensive evaluation model, the e-Learning Evaluation Tool for Algebra I Courses. This model will be used to systematically evaluate the e-learning Algebra I course that is the subject of this study.
CHAPTER V

METHODOLOGY

Introduction

This chapter discusses the methodology used to gather and analyze the data from this study. There are five sections within this chapter. The initial discussion focuses on my rationale for choosing a mixed-methods design as my methodology. The context of the study is then discussed, which includes the background of the site and the participants in the study. In the third section I will discuss my role as the researcher. This is particularly of interest since this study took place in a virtual classroom, where I was an observer but never present in the classroom. In the data and analysis section, I discuss how both the quantitative and qualitative data were collected and analyzed. Lastly, the limitations of the study are addressed.

The Rationale

In recent years, the Institute for Education Sciences (IES) has called for fully experimental, randomized research studies (U.S. Department of Education, n.d.). However, randomized sampling and random assignment is often difficult, or frequently unrealistic, in an educational research setting.

While random assignment studies are clearly the best approach to studying causal changes in educational outcomes...a variety of non-experimental quantitative and qualitative research methods [mixed-methods] may help identify the most promising interventions that in particular contexts can change the most important outcomes for target groups of learners. (Smith et al., 2005, p. 14)
With the dropout rate as high as 50% in some virtual high school courses the ability to conduct random assignments with large subject numbers in any virtual high school is often difficult. As Smith indicates, the use of mixed-methods is more likely to help identify the key concepts that influence learning outcomes. Therefore, this study was designed to be non-experimental and descriptive, using a triangulation mixed-methods research design to investigate and describe the experiences and perceptions of the students and their teacher.

The process of a triangulation mixed-methods design is to simultaneously collect both quantitative and qualitative data, which is then merged and the results are used to understand a research problem. “The basic rationale for this design is that one data collection form supplies strengths to offset the weaknesses of the other form” (Creswell, 2005, p. 514). The triangulation is the result of the comparison of the data collected and analyzed, and then, through the interpretation phase, a determination of whether the different data sets support or contradict each other (see Figure 5.1).

Figure 5.1: Triangulation Mixed-Methods Design (Creswell, 2005, p. 514)

In the case of this study, the triangulation of data was very important since the number of participants in the study was very low (n=10). Data was gathered using
quantitative surveys, student records, and online course statistics. An evaluation tool was systematically developed (see Chapter 4) and then used to examine the course’s pedagogy and design through the lens of current e-learning and mathematics best practices and the eyes of the students. The collection of qualitative data, in the form of interviews and analysis of class discussions and interactions, provided an additional lens through which I was able to examine the nuances that were not available in the quantitative data. The use of both quantitative and qualitative data allowed for a much deeper and richer opportunity to understand and describe the “story” that might not otherwise have been possible by using only one form of data collection. It should be noted that even with the telling of the story, that this study cannot and was not meant to be generalized to a greater population. It is the story of 10 students in one class in one virtual high school only.

**Context of the Study**

The site for this research was a virtual high school located in a large urban school district in the western United States. For ease of reference, the school is referred to as Any Virtual High School (AVHS). The school offers a full-time, diploma-granting, virtual school to all high school students (grades 9-12) in the district. However, the school is not restricted to full-time virtual students, as it provides part-time opportunities for students as well. During the 2004-2005 school year, the school enrollment was over 5,000 part-time and over 250 full-time students. The principal reported that the school’s completion rate was 75% to 80% (Confidential Source, 2006b\(^8\)).

---

\(^8\) This cite is listed as “confidential source” because further information would enable identification of the school district due to the small numbers of experts who are involved in virtual high schools.
The school district is one of the largest school systems in the nation, and it is also one of the nation’s fastest growing districts, opening approximately one new school building per month (Pierce, 2005). The district is growing at approximately 15,000 students per year. Table 5.1 shows the demographic breakdown of the school in relation to the entire district.

Table 5.1: Demographics of the Any Virtual High School and District (adapted from the District’s report, 2006) 2005 – 2006 District Accountability Summary Report

<table>
<thead>
<tr>
<th></th>
<th>Enrollment Numbers</th>
<th>Enrollment Percentage</th>
<th>Graduation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AVHS</td>
<td>District</td>
<td>AVHS</td>
</tr>
<tr>
<td>Total Enrollment</td>
<td>140 (FT)</td>
<td>293,801</td>
<td>100%</td>
</tr>
<tr>
<td>Male</td>
<td>52</td>
<td>151,413</td>
<td>37.0%</td>
</tr>
<tr>
<td>Female</td>
<td>88</td>
<td>142,381</td>
<td>62.9%</td>
</tr>
<tr>
<td>American Indian/Alaskan Native</td>
<td>0</td>
<td>2,465</td>
<td>0.0%</td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>11</td>
<td>24,833</td>
<td>7.9%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>13</td>
<td>108,228</td>
<td>9.3%</td>
</tr>
<tr>
<td>Black/African American</td>
<td>12</td>
<td>42,365</td>
<td>8.6%</td>
</tr>
<tr>
<td>White</td>
<td>104</td>
<td>115,710</td>
<td>74.3%</td>
</tr>
<tr>
<td>IEP</td>
<td>NR</td>
<td>31,715</td>
<td>NR</td>
</tr>
<tr>
<td>LEP</td>
<td>NR</td>
<td>50,758</td>
<td>NR</td>
</tr>
<tr>
<td>Free Lunch Program</td>
<td>NR</td>
<td>133,832</td>
<td>NR</td>
</tr>
<tr>
<td>Migrant</td>
<td>NR</td>
<td>48</td>
<td>NR</td>
</tr>
</tbody>
</table>

There are a variety of reasons why high school students choose to take their courses through the Any Virtual High School, such as illness that prevents the student from attending a traditional brick and mortar classroom, behavioral issues that preclude the student from functioning appropriately in a traditional classroom, the need for course...
recovery options due to previously failing a required course, or the desire to accelerate their high school curriculum to allow time for more advanced courses (Confidential Source, 2006a). To address these needs the AVHS offers multiple e-learning delivery methods to their students:

1. Local public broadcast instruction with e-mail for teacher-student communication,

2. VCR/DVDs for the instructional material and e-mail for communication with the instructor, and

3. Blended web-based instruction and e-mail, asynchronous discussion groups, and weekly synchronous computer-assisted conferencing with fellow students and the instructor (Confidential Source, 2006a).

This study evaluated the third delivery method, the web-based instruction. The subjects of the study were high school students who were taking an Algebra I course in a web-based classroom. Algebra I was chosen as the subject matter for the study because this course is considered the gateway to higher mathematics courses. As such, many school districts are requiring all students to take Algebra I to graduate. Consequently, I expected the demographics of the students in an Algebra I course to be quite diverse, which would provide an opportunity to study how the different types of students perceive their experience in a virtual high school. However, this study ultimately had only 10 students participate and the diversity of the students was not as broad as was expected.

The course utilizes both asynchronous (not real-time) and scheduled synchronous (real-time) instruction to enhance the learning experience. The asynchronous instruction

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9 This cite is listed as “confidential source” because further information would enable identification of the school district due to the small numbers of experts who are involved in virtual high schools.
involved accessing, over the Internet, the course materials, assignments, text-based and PowerPoint presentations, embedded media, discussion forums, tests, and grades via WebCT, a web-based course management software. Students followed a prescribed schedule, downloaded instructional materials, participated in asynchronous discussions, and communicated with their teacher through e-mail (Confidential Source, 2006a). The features of WebCT are listed in Figure 5.2.

**WebCT Course Design Features:**
- online syllabus
- online media integration
- course navigation and web links
- asynchronous discussion forums
- instructor announcements
- access to assignments
- synchronous chat conversations and white boarding sessions
- e-mail access
- online quizzes and tests
- online surveys and self-assessment tools
- online grade book

Figure 5.2: WebCT course management software features (WebCT.com, n.d.)
In addition to using WebCT, the students were required to attend weekly synchronous computer-assisted conferences using Centra, a Voice-over-IP (VoIP) software package. VoIP technology allows voice communications to be transmitted over the Internet. Using this technology, Centra provides a real-time (synchronous) virtual classroom over the Internet that allows for live interaction between the instructor and all of the students, small group work, group and individual presentations, document sharing, and immediate feedback. Through Centra and the use of a microphone headset attached to the teacher’s and students’ computers, all the participants have the ability, in real-time, to hear each other’s comments, conduct both private and public online chats, send emails to each other or the instructor, and view presentations, instructor-accessed web pages, and whiteboard instruction of mathematical explanations. Everyone can see each other names listed in the class. The teacher controls the environment, but at any time she can hand over the controls to a student. Students may raise their hand to ask or answer a question, or make a comment. The teacher may poll the students to determine if any one has a question before moving on to the next topic. Each Centra session may be recorded and accessed later by the students registered in the class. Students not registered in the class do not have access to either the real-time session or the playback. The features of Centra are listed in Figure 5.3.

The study’s participating teacher, Ms. Smith, is a Caucasian female in her late thirties. She is a state licensed secondary mathematics (7th-12th) teacher, who has taught secondary mathematics for eight years. In the past, she taught at the local magnet high school for advanced technologies, which serves gifted students interested in technology. She recently joined the AVHS staff and has been teaching online mathematics for two
years. Her first year she taught algebra part-time and, the next year, she became a full-time algebra teacher. Her academic background includes a B.S. degree in secondary education mathematics and an M.Ed. degree in Curriculum and Instruction. Ms. Smith was recruited during my visit to AVHS to investigate the possibility of using the school as the site for the study. At that time, Ms. Smith volunteered to participate in the study, and the school and district administrators approved the study and Ms. Smith’s involvement.

Centra Course Design Features:

- Virtual Classroom over the Internet (recorded for future access)
- Real-time interactions (everyone can hear each other)
- Whiteboard for concept explanations
- Viewable presentations (i.e., PowerPoint slides, and media)
- Breakout rooms for small group discussion and projects
- Integrated text chats
- Web Safaris for sharing websites
- Application Sharing (i.e., graphing calculators)
- Evaluations (i.e., tests, quizzes, surveys)

Figure 5.3: Centra Virtual Classroom (Saba, n.d.)
The students participating in the study were enrolled in the 1st Semester Algebra I e-learning course during the Fall 2006 at the Any Virtual High School. AVHS does not offer a continuous Algebra I course over two semesters. Rather, the school splits the first semester and the second semester into two separate courses. In any given semester, one or both semester courses may be offered. The initial enrollment was 41 students. The students were initially briefed by the teacher that a researcher would be contacting them and their parents to request their participation. Once the students were aware of the potential contact, information and consent forms were sent to all the students and their parents (see Appendix K). Stamped, self-addressed envelopes were provided for the return of the signed consent forms. Follow-up phone calls and emails were made when necessary to clarify questions.

Before the research forms even arrived, several students had already dropped the class. By the semester’s end, all but 15 students dropped out of the course. Of the 15 remaining students, 10 students completed the study. Eight students were 9th graders and one student was a 10th grader. There were nine girls and one boy that completed the study. These 10 students did not represent a typically diverse classroom academically. All but one student was academically at-risk. Table 5.2 presents the demographic information of the participants.

Table 5.2: Study participants, including the teacher

<table>
<thead>
<tr>
<th>Name**</th>
<th>Role</th>
<th>Gender</th>
<th>Race</th>
<th>Age</th>
<th>Grade Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ms. Smith</td>
<td>Teacher</td>
<td>Female</td>
<td>Caucasian</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Ann</td>
<td>Student</td>
<td>Female</td>
<td>Caucasian</td>
<td>14</td>
<td>9th</td>
</tr>
<tr>
<td>Cindy</td>
<td>Student</td>
<td>Female</td>
<td>Caucasian</td>
<td>15</td>
<td>9th</td>
</tr>
<tr>
<td>Karen</td>
<td>Student</td>
<td>Female</td>
<td>Caucasian</td>
<td>16</td>
<td>9th</td>
</tr>
</tbody>
</table>
**The Role of the Researcher**

I am a middle-aged, middle-class Caucasian woman, who is also a wife and mother. I have pursued educational opportunities throughout my entire life. I earned my bachelor of science in Biology at a small liberal arts university in the western United States. I attended graduate school to pursue a Masters degree, completed the requirements for a teaching credential, and began teaching Biology in a large urban high school.

With my commitment to my family and the financial need to work fulltime, I felt I had little possibility of continuing my education until one day I discovered an online Masters in Educational Technology and Leadership offered through George Washington University. So without hesitation, I applied and after two long years I graduated. During those two years, I often studied at rather unusual hours and in rather unusual places. I squeezed my studies into my life wherever and whenever I could. Without the flexibility of online instruction, I would not have attained my Masters degree. In adult education, this is a common scenario that attracts students to online higher education opportunities. Although the reasons for attending a virtual school may vary with high school students,
districts are attempting to fulfill the needs of students who express interest in alternative educational opportunities.

Since earning my Masters degree, I have experienced online learning from two additional perspectives: as the instructor and as the developer. From my experiences I have encountered various approaches to online learning, not all of which were positive. It is from this experience that I recognize the potential for bias in this study. However, because I have experienced both positive and negative experiences in online education, I believed that my focus in this study was to discover the truth as it applies to the high school student enrolled in a virtual high school. It may seem like virtual high schools provide a viable alternative, but in my mind I had not made any decision that leaned in one direction or the other. I was able to espouse the potential but was not convinced of its merits. Thus, I believe that I entered this study with an open mind. I was, and continue to be, especially committed to understanding the roles that pedagogy and theory may play in the delivery and effectiveness of e-learning.

In my role as a quantitative researcher, I was the observer who had no interaction with the subjects. I was a gatherer of numbers and statistics from the district-provided documentation and the administered surveys. The surveys were not created by me. They were the work of other researchers who validated their work in other studies. Thus, the surveys in this study did not represent a bias specifically associated with me, although one might say that I chose the specific surveys to use and that may introduce a bias. In my role as the qualitative researcher, I was a human instrument of data collection (Hoepfl, 1997). In most qualitative studies the researcher takes the role of either the observer as participant or the participant as observer. As the observer as participant, there
is some, but not extensive, interaction between the subjects and the researcher. As the participant as observer, the researcher becomes part of the social setting, interacting extensively (Glesne, 1999).

In this study, I defined myself as a variation on the observer as participant. Although I was able to observe each classroom session and each discussion forum, the process was completely online and asynchronous. At no time was I present and interacting in the real-time classroom sessions over Centra. My observations were gathered through the recorded sessions. Rather than sitting in the back of the classroom, I was sitting in the back of the theatre. The same was true for the weekly discussion forums held in WebCT. The discussion forums were conducted asynchronously and the transcripts were saved. As the observer, I downloaded the transcripts, but did not participate in the discussions. It was during the interview process that I became a participant. Interviews are always subject to researcher bias. Consequently the interviewer may receive answers the interviewee believes is what the interviewer wants to hear. For that reason, I had my interview questions reviewed before I conducted the interviews to ensure that the questions were worded properly, showed no bias, and flowed appropriately. Using the mixed-methods approach provided me with alternate data from which to highlight and control any bias I may possess.

**Data Collection and Analysis**

This discussion is sub-divided into three sections to clarify the entire data collection and analysis process. The Section I discusses the quantitative data collection and analysis. A discussion of the qualitative data collection and analysis follows in
Section II. Section III discusses the data and analysis that was performed using the e-Learning Evaluation Tool for Algebra I Courses (e-LETAC).

Section I: Quantitative Data Collection and Analysis

“Survey research designs are procedures in quantitative research in which investigators administer a survey to a sample or to the entire population of people in order to describe the attitudes, opinions, behaviors, or characteristics of the population” (Creswell, 2005 p. 354). Statistics Surveys, as defined by Creswell (2005), serve well in the gathering of data that speaks to the trends and issues within the virtual high school environment. Several surveys have been conducted to gather information on the current trends and issues within the virtual high school setting. Two capstone studies were conducted using online surveys to identify virtual school activities and trends within the United States (Clark, 2001, 2004). These studies are referenced in many research papers and books concerned with current trends within the virtual high school movement (e.g., Cavanaugh, 2004; Berge & Clark, 2005; Fulton, 2002b; Roblyer, 2003). National surveys were conducted in the past two years to gather a comprehensive database on the nature and trends within the nation’s distance education and/or online K-12 public schools (Setzer & Lewis, 2005; Picciano & Seaman, 2007). However, very few quantitative surveys have been used to research issues in virtual schooling other than the associated trends and implementation, despite the inclusion of correlational and survey research in IES’ priority list for educational research designs (U.S. Department of Education, n.d. as cited in Smith et al., 2005). In contrast to past survey research, this study used
quantitative surveys that moved beyond trends and implementation, and into the theoretical underpinnings of students’ perceptions of their online learning experiences.

To investigate and answer the first research question, quantitative data was collected through the four comprehensive surveys (see Appendices A-H) that asked the students about their attitudes towards mathematics, what factors contributed to their perceptions of distance and presence in the course, and if they were motivated in the course. Each survey was slightly adapted so that the language and questions were relevant to the virtual high school student and e-learning environment, as well as abbreviated, where necessary, to avoid overly lengthy survey instruments. The adapted surveys were reviewed by two experts in the field of virtual high schools, and a science educator/researcher, to ensure that any adaptations were appropriate for the study’s subjects.

- Ms. Liz Pape, the CEO and president of the VHS located in Massachusetts,
- Dr. Catherine Cavanaugh, an assistant professor in curriculum and instruction at the University of Florida, and a prominent researcher in virtual high schools and mathematics, and
- Dr. Elaine Parsons, an assistant professor of secondary science education at the University of North Carolina at Chapel Hill.

Prior to disseminating the surveys, copies were reviewed and approved by the district’s director for research and school improvement.

The surveys were administered separately, and they were spaced out over the semester to prevent the students from becoming overwhelmed with one large survey that

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10 See Appendices A-H for specific changes. Details on the adaptations follow on page 158. There were no changes to the actual content or purpose of the surveys.
would take a long time to complete. This was the specific recommendation of the participating teacher. Each survey was created using the Qualtrac’s online survey service in partnership with the UNC Odum Institute. The students accessed the surveys through my personal website, which gave them an opportunity to learn more about me and see my picture prior to taking the surveys or participating in an interview. I hoped that using my website helped personalize the experience for the students. The completion of each survey took approximately 20 minutes. Table 5.3 provides the administration schedule for the survey instruments. In some cases, the original survey may not have been administered online and thus this difference in administration may present a limitation to the study that is addressed in Chapter 7.

The following surveys were administered, in the order below

1. **The Fennema-Sherman Mathematics Attitudes Scale** (Fennema & Sherman, 1976). The Fennema-Sherman Mathematics Attitudes Scales (FSMAS) is among the most cited mathematics survey in educational psychology journals (Forgasz et al., 1999). The FSMAS consists of nine scales measuring confidence, effectance motivation, mathematics anxiety, and usefulness of mathematics, attitude toward success, mathematics as a male domain, father, mother, and teacher attitudes (Forgasz et al., 1999). It has been validated and used extensively over the past 30 years, either in its full version (Forgasz et al., 1999; Thompson et al., 1993) or in an abbreviated version (Mulhern & Rae, 1998; TERC, 1997). Other researchers have chosen to use one or more of the individual scales to research very specific issues (Iben, 1991; et al., 1998) (See Appendix A).

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11 Formal written permissions to use these surveys were attained from each survey’s developer/researcher.
This study included three of the instrument’s scales:

A. Confidence in Learning Mathematics Scale

B. Mathematics Anxiety Scale

C. Effectance Motivation in Mathematics Scale

These scales were chosen due to the relevance to a student’s motivation to learn (Keller, 1997) and to identify specific mathematics attitudes of the subjects.

2. **Course Interest Survey** (Keller, 2006). The Course Interest Survey (CIS) was developed to gauge student motivation related to a specific course. This instrument was designed to measure student motivation within a specific course, and as such, it is a situational measure of motivation. The instrument was developed to measure the motivational constructs of the ARCS Model of Motivational Design and has been used extensively and validated in multiple settings (Gabrielle, 2003; Huett, 2006; Keller & Suzuki, 2004; Song & Keller, 1999, 2001) (See Appendix C).

3. **The Scale of Transactional Distance (Zhang, 2003)**. There are very few instruments to measure transactional distance quantitatively. Zhang’s scale is the first of its kind to measure quantitatively individual perceptions of transactional distance specifically within web-based college courses. The scale was created under strict guidance from experts in the field and rigorous validity and reliability analyses (see Appendix E).

4. **Social Presence Questionnaire** (Gunawardena & Zittle, 1997). The Social Presence Questionnaire measures the students’ perception of social presence and
satisfaction. The social presence scale contains fourteen questions that the researchers felt “embodied the concept of immediacy” (p. 15). The satisfaction scale contains ten items that measure the students’ perceptions of learning within a CMC environment and their motivation to continue. This survey was used by other researchers (e.g., Richardson, 2001; Richardson & Swan, 2003) to evaluate students’ perceptions of social presence in online courses (see Appendix G).

Students completed each survey during a prescribed period within the semester (see Table 5.3). The Fennema-Sherman survey was administered within the first month of the course and at the end of the course. During the first administration of the Fennema-Sherman survey, some additional questions were appended to the survey. Included in the first survey were:

- Demographics questions,
- Four questions concerning the student’s comfort level with technology,
- Two questions asking why the student chose to take Algebra I,
- Two questions asking why the student chose to take an e-learning course, and
- Three questions from the course interest survey.

The addition of these questions provided some essential information that had not been covered by any of the surveys. The questions from the CIS were placed in the first survey to help determine if there were any changes in the students’ motivation during the course. These extra questions were removed before the survey was administered at the end of the course. Administering the Fennema-Sherman survey twice provided me some insight into whether there were any changes in the students’ attitudes towards mathematics.
The Social Presence Questionnaire, the Transactional Distance Survey, and the Course Interest Survey were administered over the course of two weeks prior to the end of the course. The data from each of these surveys was scored in accordance with the specific survey and then descriptive statistics were generated to discover what trends or relationships existed. In addition, the survey data was compared against the students’ demographic data and their academic achievement in the course.

Contributions to discussion forums and course statistics, such as the number of hits a student makes to the different pages within WebCT, was quantified to provide a numerical picture of each interviewees’ actual participation in the course and to evaluate if the numerical contributions relate closely to the interviewees’ perception of participation and the theoretical constructs within the study. Researchers have used this analytical approach to discover relationships with the constructs described within this study (Gabrielle, 2003; Kim, 2004; Tu, 2000).

In statistics, a relationship suggests that two variables may have an interconnection but there may not be a cause and effect between the variables. In the results section of this study the words “related” and “relationship” may be used interchangeably but the researcher’s use of these words DOES NOT imply that she has proven any causation. The terms are used simply to speculate that a pattern or trend may exist between two or more variables but nothing statistically significant is claimed. As stated in Creswell (2005), such “conclusions do not establish a probable cause-and-effect relationship” (p. 327).
Section II: Qualitative Data Collection and Analysis

Qualitative methods, such as interviews, focus groups, and open-ended questionnaires, have been used in past tertiary-level, online learning research studies on social presence (Picciano, 2002; Richardson, 2001; Richardson & Swan, 2003; Witmer & Singer, 1998), transactional distance (Lally & Barrett, 1999), math anxiety (Furner, 1996; Waxman & Huang, 1996), and motivation (Roblyer, 1999). With the exception of math anxiety and motivation, there are few, if any, research studies that measure these constructs in secondary online learning. The complexity of these constructs on a secondary student’s perceptions of her online educational experience warrants the use of qualitative methods to discover underlying nuances that would not be observed through surveys alone.

Qualitative methods are generally supported by the interpretivist (also referred to as constructivist) paradigm, which portrays a world in which reality is socially constructed, complex, and ever changing….social realities are constructed by the participants in those social settings. To understand the nature of constructed realities, qualitative researchers seek out the variety of perspectives; they do not try to reduce the multiple interpretations to a norm. (Glesne, 1999, p. 5)

Using qualitative methods in this study provides the researcher a means of contextualizing the perceptions of the subjects to form a deeper understanding of how all participants in the study interact and perceive their learning environment. Such information may provide information that might otherwise fall through the cracks of the surveys, as well as provide further triangulation of the data. The qualitative data collected in this study through interviews, observations, and analysis of documentation provided a triangulated view of the data and built a clearer and more comprehensive picture of the research problem.
Initial discussions with the teacher and administrators confirmed that the best way to conduct interviews with the students was through Centra, rather than attempting face-to-face sessions, as the students were spread out and it is difficult to entice them to come into any central place for an interview. Both the school administration and the teacher were confident that the students would be very comfortable participating in an online interview. Therefore, the interviews were conducted online using Centra or by a telephone conversation. Telephone interviews were conducted only if the student did not have audio capability in Centra due to a malfunctioning microphone or other technical issue. The interview questions were developed and reviewed by two committee members to ensure the language and content of the questions were appropriate for the age of the subjects and would help discover the information sought in the study (see Appendix I).

Due to the small number of participating subjects, all student participants were invited to participate in two open-ended interviews to gather supplemental qualitative data and to follow up on trends identified by the survey instruments. The interviews of the students were conducted midway through the course and at the end of the course. Every interview was recorded using the recording function of Centra. This was possible since all of the students had access to a broadband Internet connection that supported Centra. One interview was conducted through Centra using the text chat function that allowed the student’s written answers to be transcribed and saved. This student did not have a functioning microphone but could hear my side of the conversation, so she chose to participate via Centra instead of the telephone. The data from the first interview was reviewed three times to ensure that my trend analysis was consistent throughout the study. Due to the simplicity of the interview data, elaborate coding was not used during
the study. This approach was approved by the qualitative methodologist on my committee. After the first interview, the questions for the second interview were developed to pursue information that was missing from the first interview. This process was discussed with the qualitative methodologist on my committee before proceeding. Following the students throughout the course provided me an in-depth examination of these students’ perceptions and attitudes that would not have been possible with survey data alone.

Thirty-four discussion transcripts, one per interface per each week of the course, were gathered from the recorded sessions available through the Centra and the WebCT interfaces. In an online world, reading text-based asynchronous discussions is comparable to direct observation of face-to-face classroom discussions. The online synchronous classroom presentations and discussions conducted through Centra also provide a rich opportunity to observe classroom interaction, as well as the teacher’s instructional strategies.

These observations were recorded within WebCT and Centra and downloaded for each week of the course. Each week’s observations were examined for categories, themes, patterns and surprises might provide further insight into students’ attitudes and perceptions, and to expose any potential relationships between the interactions and the interview responses. I evaluated each Centra session three times to ensure that I was not missing any relevant information. The instruction and interaction in the Centra sessions was very consistent and repetitive. There were no diversions from the weekly pattern or surprises. Participation in the WebCT discussion was minimal and did not require multiple evaluations. This phenomenon is reflected in the final data analysis. In addition,
Dr. Jan Yow, who was a former secondary algebra teacher familiar with reform-based mathematics, independently evaluated a typical session in both Centra and WebCT, which provided inter-rater reliability in the evaluation of the instruction and content. See Table 5.3 for when the interviews and other the documentation were collected.

Section III: e-LETAC Data Collection and Analysis

The e-LETAC evaluation tool (see Figure 4.5) was created using a framework I developed by very deliberately blending of the NCTM recommended mathematics pedagogy and algebra content standards, and the suggested e-learning design and pedagogy standards from the NEA, and SREB. The tool allowed me to rate the various aspects of the course on a scale of one to three. If there was any issue that was not clear, comments were made in the “Comment Box” to provide a qualitative manner that allowed formative feedback to be noted. The lowest score the course could receive was 101, not meeting any of the criteria, and the highest score the course could receive was 303, meeting all of the criteria. This evaluation was completed after the course was finished, and the Centra sessions and WebCT data were downloaded so the evaluation could be completed off-line. Various areas of the course that were used as evidence to evaluate the course included:

- The syllabus and other available resources,
- The WebCT and Centra navigation environment,
- The WebCT and Centra discussion transcripts,
- The course assignments and tests, and
- The interviews with the students and the teacher.
The evidence from each of these areas of the course was then directly compared to each indicator of the evaluation tool.

Table 5.3: Data collection schedule

<table>
<thead>
<tr>
<th>Surveys</th>
<th>Administration Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fennema-Sherman Mathematics Attitudes Survey</td>
<td>September 30th - October 10th</td>
</tr>
<tr>
<td>Social Presence Questionnaire</td>
<td>December 14th - 22nd</td>
</tr>
<tr>
<td>Scale of Transactional Distance</td>
<td>December 14th - 22nd</td>
</tr>
<tr>
<td>Motivation Survey (Course Interest Survey)</td>
<td>December 22nd – January 10th</td>
</tr>
<tr>
<td>Fennema-Sherman Mathematics Attitudes Survey (without additional questions)</td>
<td>January 1st-10th</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interviews</th>
<th>Interview Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Student Interviews</td>
<td>October 25th – November 15th</td>
</tr>
<tr>
<td>2nd Student Interviews</td>
<td>January 3rd – 10th</td>
</tr>
<tr>
<td>1st Teacher Interview</td>
<td>September 10th</td>
</tr>
<tr>
<td>2nd Teacher Interview</td>
<td>October 31st</td>
</tr>
<tr>
<td>3rd Teacher Interview</td>
<td>December 27th</td>
</tr>
<tr>
<td>Ongoing Teacher-Researcher Communication via Email</td>
<td>Weekly to Bi-weekly email exchanges for clarification of evolving questions and to simply touch base with the teacher</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student Documentation</th>
<th>Recommended Gathering Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection of Student Records from School</td>
<td>October 24th</td>
</tr>
<tr>
<td>Collection of Student WebCT Discussions and Course Statistics</td>
<td>January 15th – 30th</td>
</tr>
<tr>
<td>Collection of Centra Weekly Playbacks</td>
<td>January 15th – February 20th</td>
</tr>
<tr>
<td>Course Evaluation using e-LETAC</td>
<td>March 1st - March 25th</td>
</tr>
</tbody>
</table>

**Conclusion**

The mixed-methods research design I selected for this study allowed me to collect both quantitative and qualitative data that provided a clearer picture of the research issues at hand. With only 10 students in the study, I could not rely solely on survey data to
provide a clear picture of the relationships and nuances that might occur during the study. The qualitative data helped support and even fill in missing information that was not obvious from the surveys. In addition, the use of mixed-methods provided the much needed triangulation of data that helped to assure me that what I thought I saw was not a factor of my bias as a researcher. The evaluation of the course in terms of the quality of the teacher, the instructional design, and the support systems in place added yet another view from which to answer the research questions. The next chapter details the analysis and results of the study.

This study does not make any attempts to control the variables that may affect the outcomes of the results. This is not an experimental study and it does not use inferential statistical analyses to infer causation. All statements of potential relationships are preliminary and speculative due to the low number of participants and the lack of an experimental design.
CHAPTER VI

ANALYSIS AND RESULTS

Introduction

It was the purpose of this study to investigate secondary students’ motivation to learn, mathematics attitudes, and perceptions of transactional distance and social presence in an Algebra I course offered in an urban virtual high school. Included in this purpose was an investigation into what instructional practices students perceive as improving instruction, as well as an evaluation of the course’s pedagogy in light of current e-learning and mathematics best practices. No formal research has been identified that specifically addresses the virtual high school students’ experiences in relation to these constructs that underlie effective e-learning and mathematics pedagogy.

The study presented here was designed to examine 41 online students of various backgrounds and gender. Ultimately, the study specifically involved 10 virtual high school students, nine of whom were considered academically at-risk. The study examined students’ motivation to learn, mathematics attitudes, and their perceptions of transactional distance and social presence when taught Algebra I in e-learning environment that utilizes both asynchronous (not real-time) and scheduled synchronous (real-time) instruction. The goal of the study was to investigate secondary students’ experiences in an e-learning Algebra I course and how those experiences related to their specific learner profiles and achievement.
The results of this study are reported in three sections corresponding to the three research questions in the study. The specific research questions addressed were:

I. Are the motivations to learn, mathematics attitudes, and perceptions of transactional distance and social presence of secondary students enrolled in a virtual high school Algebra I course in an e-learning environment related to their respective learner profiles and mathematics achievement?

II. How might the design, including the pedagogical practices, of a secondary virtual e-learning Algebra I course be described in light of existing principles of best practices in mathematics and a virtual learning high school environment?

III. What specific pedagogical practices are perceived by secondary students enrolled in a virtual high school Algebra I course in an e-learning environment as contributing to their motivation to learn, mathematics attitudes, and perceptions of transactional distance and social presence?

To answer the research questions, a triangulation mixed-methods design was used to simultaneously collect and analyze quantitative and qualitative data and then merge the results to understand each research question. Through the interpretation of the data it was possible to speculate if the different data sets supported or contradicted each other. This process allowed me to discover where there were consistencies in the participants’ experiences and where questions still remained unanswered.

Section I: Research Question I

Are the motivations to learn, mathematics attitudes, and perceptions of transactional distance and social presence of secondary students enrolled in a virtual high school Algebra I course in an e-learning environment related to their respective learner profiles and mathematics achievement?
To answer the first research question, a series of four surveys were administered to the students during the fall school semester. The first survey, the mathematics attitude survey, included a few questions about the student’s demographics and motivation. Learner profiles were developed from the results of the first survey, the demographic information, past mathematics achievement, previous mathematics courses, and self-reported information gathered during the student interviews.

This section is divided into three sub-sections. The first sub-section presents both quantitative and qualitative data used to develop each student’s learner profile. Each student’s profile is individually presented. The second sub-section presents the quantitative and qualitative data used to understand the students’ mathematics attitudes, motivation in the virtual Algebra I course, and perception of transactional distance and social presence in the course. The third sub-section combines the data and conclusions from the first two sub-sections and provides an interpretation of relationships that were identified during this analysis. In this section the words “related” and “relationship” are frequently used. In this study the use of these words does not imply causation. The terms are used to suggest that some type of interaction may exist between two or more variables.

**Learner Profiles**

Fourteen variables contribute to the development of each student’s learner profile.

1. **Gender** — F = Female, M = Male
3. **Age**
4. **Current Grade Level**— the grade level assigned to the student for Fall 2006

5. **Prior Grade Level**— the grade level assigned to the student for Fall 2005

6. **Prior Mathematics Course**— the mathematics course completed the year before Fall 2006. In some cases, this information is self-reported by the student because the district did not have previous academic records for the student.

7. **Prior Mathematics Grade**— for the mathematics course completed the year before Fall 2006. In some cases, this information is self-reported by the student because the district did not have previous academic records for the student.

8. **Pre-Mathematics Confidence Score**— acquired from the first mathematics attitude survey, which included a sub-score for confidence in mathematics. This score represents the level of confidence to perform well in mathematics the student possesses. The scores range from one to five, with one representing high confidence in one’s performance ability in mathematics. Five represents low confidence.

9. **Pre-Math Anxiety Score**— acquired from the first mathematics attitude survey, which included a sub-score for math anxiety. This score represents how much anxiety a student experiences in relation to mathematics in general. The scores range from one to five, with one representing low math anxiety. Five represents high math anxiety.

10. **Pre-Mathematics Self-Efficacy (Effectance) Score**— acquired from the first mathematics attitude survey, which included a sub-score for mathematics self-
efficacy. This score represents the level of self-efficacy the student possesses in mathematics in general. The scores range from one to five, with one representing high level of self-efficacy. Five represents a low level of self-efficacy.

11. **Pre-Mathematics Attitude Average** — the average of the confidence, anxiety, and self-efficacy scores. The scores range from one to five, with one representing a high positive attitude towards mathematics in general. Five represents a negative attitude towards mathematics in general.

12. **Pre-Confidence Score** — this score represents the average of the responses to two motivation statements on confidence from the Course Interest Survey that was included in the first mathematics attitude survey. The statements included were:

   a. I feel confident that I will do well in Algebra I.
   
   b. Whether or not I succeed in Algebra I is up to me.

This score represents the level of confidence the student possesses in a specific course, in this case, an online Algebra I course. The scores range from one to five, with one representing less confidence in one’s performance ability in Algebra I. Five represents high confidence. When interpreting this score, it is important to remember that the scale is the opposite from the mathematics attitude scale.

13. **Pre-Relevance Score** — this score represents the average of the responses to two motivation statements on relevance from the Course Interest Survey that
was included in the first mathematics attitude survey. The statements included in the survey were:

a. To accomplish my goals, it is important that I do well in this class.

b. I do NOT think I will benefit much from this class.

This score represents how relevant a specific course, in this case, an online Algebra I course, is to the student. The scores range from one to five. A score of one indicates the student perceives the Algebra I course is not relevant to his goals. Five indicates the course is perceived as very relevant. In interpreting this score, it is important to remember that the scale is the opposite from the mathematics attitude scale.

14. **Pre-Motivation Score**— the scores from the Pre-Confidence and Pre-Relevance statements were averaged to provide a single motivation score. This score represents the level of motivation the student experiences in a specific course, in this case, an online Algebra I course. The scores range from one to five, with one indicating the student experiences low overall motivation to learn in the online Algebra I course. A score of five indicates the student experienced a high overall motivation to learn. In interpreting this score, it is important to remember that the scale is the opposite from the mathematics attitude scale.

Table 6.1 summarizes the students’ descriptive statistics and survey scores that are used to develop a quantitative profile of each student in the study. The students’ individual profiles follow the table and include the qualitative data gathered from the student
interviews, self-reported individual profiles in the WebCT discussion forum, and the few open-ended questions included in the first mathematics attitude survey.

The interpretation of each student’s survey scores is in some cases, a judgment call, as many of the students’ scores are just slightly on one side or the other of the mid-range (3 out of 1 to 5). The further away the student’s score is from the mid-range, the more that student’s response is considered to be leaning towards one end or the other of the full range of scores. Generally, a score that ranges from between 2.5 to 3.5 was considered representing a mid-range score, indicating the student was either indifferent or unsure. In cases where the scores required more interpretation, a student’s self-reported information during the interview process was considered in order to clarify an interpretation of the individual student’s attitudes. For example, a student is considered as leaning towards a poor mathematics attitude if the student’s score was higher than 3.5. Any student with an overall score lower than 2.5 is considered to be leaning towards a positive mathematics attitude. Then, qualitative data are examined to determine if what the student said during an interview reinforced or denied conclusions are drawn from the survey data. Any inconsistencies are reported.
Table 6.1: Learner Profiles based on descriptive statistics prior to completing Algebra I Online

<table>
<thead>
<tr>
<th>Name</th>
<th>Gender</th>
<th>Race</th>
<th>Age</th>
<th>Current Grade</th>
<th>Prior Grade</th>
<th>Prior Mathematics Course</th>
<th>Prior Mathematics Grade</th>
<th>Pre-Mathematics Confidence**</th>
<th>Pre-Math Anxiety**</th>
<th>Pre-Mathematics Self-Efficacy**</th>
<th>Pre-Mathematics Attitude Average**</th>
<th>Pre-Confidence***</th>
<th>Pre-Relevance***</th>
<th>Pre-Motivational Average***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ann</td>
<td>F</td>
<td>C</td>
<td>14</td>
<td>9th</td>
<td>8th*</td>
<td>Algebra I Video 1st/2nd Terms*</td>
<td>F/F*</td>
<td>1.92</td>
<td>2.75</td>
<td>2.42</td>
<td>2.36</td>
<td>3.5</td>
<td>4</td>
<td>3.75</td>
</tr>
<tr>
<td>Karen</td>
<td>F</td>
<td>C</td>
<td>16</td>
<td>9th</td>
<td>9th*</td>
<td>Algebra I Video 1st/2nd Terms*</td>
<td>F/F*</td>
<td>3.08</td>
<td>3.33</td>
<td>2.5</td>
<td>2.97</td>
<td>3</td>
<td>3.5</td>
<td>3.25</td>
</tr>
<tr>
<td>Mike</td>
<td>M</td>
<td>C</td>
<td>14</td>
<td>9th</td>
<td>8th*</td>
<td>Pre-Algebra*</td>
<td>Passed*</td>
<td>2.08</td>
<td>2.83</td>
<td>2.58</td>
<td>2.5</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Sherry</td>
<td>F</td>
<td>C</td>
<td>15</td>
<td>9th</td>
<td>9th</td>
<td>Algebra I A 1st Term</td>
<td>F</td>
<td>4.5</td>
<td>4.08</td>
<td>3.92</td>
<td>4.17</td>
<td>3</td>
<td>3.5</td>
<td>3.25</td>
</tr>
</tbody>
</table>

* Information derived from student self-reporting, district documentation not available
** The lower the score the more positive were the student’s attitudes (Scores were from 1 to 5, with 3 as neutral)
***The higher the score the more positive were the student’s attitudes (Scores were from 1 to 5, with 3 as neutral)
† All names were replaced with pseudonyms
Table 6.1 - Continued : Learner Profiles based on descriptive statistics prior to completing Algebra I Online

<table>
<thead>
<tr>
<th>Name</th>
<th>Gender</th>
<th>Race</th>
<th>Age</th>
<th>Current Grade Level</th>
<th>Prior Grade Level</th>
<th>Prior Mathematics Course</th>
<th>Prior Mathematics Grade</th>
<th>Pre-Mathematics Confidence**</th>
<th>Pre-Math Anxiety**</th>
<th>Pre-Mathematics Self-Efficacy**</th>
<th>Pre-Mathematics Attitude Average**</th>
<th>Pre-Confidence***</th>
<th>Pre-Relevance***</th>
<th>Pre-Motivation Average***</th>
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</thead>
<tbody>
<tr>
<td>Maria</td>
<td>F</td>
<td>L</td>
<td>16</td>
<td>10th</td>
<td>9th</td>
<td>Algebra I 1st/2nd Terms ('05 &amp; '06)</td>
<td>F/F F/F</td>
<td>4.33</td>
<td>4.83</td>
<td>4.08</td>
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<td>2.5</td>
<td><strong>2.25</strong></td>
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<tr>
<td>Susan</td>
<td>F</td>
<td>A-A</td>
<td>14</td>
<td>9th</td>
<td>8th*</td>
<td>Algebra I A 1st/2nd Terms</td>
<td>Passed*</td>
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<td><strong>1.22</strong></td>
<td>5</td>
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<td><strong>4.5</strong></td>
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<tr>
<td>Kendra</td>
<td>F</td>
<td>A-A</td>
<td>15</td>
<td>9th</td>
<td>9th*</td>
<td>Algebra I 1st/2nd Terms*</td>
<td>Passed*</td>
<td>4.58</td>
<td>4.92</td>
<td>4</td>
<td><strong>4.5</strong></td>
<td>3</td>
<td>3.5</td>
<td><strong>3.25</strong></td>
</tr>
<tr>
<td>Sally</td>
<td>F</td>
<td>C</td>
<td>15</td>
<td>9th</td>
<td>9th</td>
<td>Algebra I 1st/2nd Terms</td>
<td>F/F</td>
<td>3.83</td>
<td>4.33</td>
<td>4.33</td>
<td><strong>4.17</strong></td>
<td>2.5</td>
<td>3.5</td>
<td><strong>3</strong></td>
</tr>
<tr>
<td>Kim</td>
<td>F</td>
<td>C</td>
<td>15</td>
<td>9th</td>
<td>9th</td>
<td>Algebra I A 1st Term</td>
<td>D</td>
<td>2</td>
<td>2.5</td>
<td>2.83</td>
<td><strong>2.44</strong></td>
<td>4.5</td>
<td>4.5</td>
<td><strong>4.5</strong></td>
</tr>
</tbody>
</table>

* Information derived from student self-reporting, district documentation not available
** The lower the score the more positive were the student’s attitudes (Scores were from 1 to 5, with 3 as neutral)
***The higher the score the more positive were the student’s attitudes (Scores were from 1 to 5, with 3 as neutral)
† All names were replaced with pseudonyms
Ann

Table 6.2: Ann’s Learner Profile

<table>
<thead>
<tr>
<th>Math Confidence</th>
<th>Math Anxiety</th>
<th>Math Self-Efficacy</th>
<th>Pre-Mathematics Attitude</th>
<th>Pre-Confidence</th>
<th>Pre-Relevance</th>
<th>Pre-Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.92</td>
<td>2.75</td>
<td>2.42</td>
<td><strong>2.36</strong></td>
<td>3.50</td>
<td>4.00</td>
<td><strong>3.75</strong></td>
</tr>
</tbody>
</table>

Ann is a 14 year old Caucasian, who successfully completed 8th grade, but was repeating Algebra I this year due to failing the course last year. She reports that her favorite hobbies include dirt biking, fishing, guns, wakeboarding, biking, swimming, and cooking. In her WebCT class profile she said that one of her goals was to get one of her “stories posted on a website for people to read and maybe to get one published someday.” She also is involved in People Synergistically Involved, an organization whose goal is to create world peace one mind at a time. She is a member of the AVHS Student Council. Her life goal is to become either a veterinarian or a graphics designer, but her first choice is to become a graphics designer. Although Ann was very open in her interviews, it was difficult to get her to follow through with her obligations to the study. My impression from my email and telephone exchanges was that her lack of follow through was not due to any resentment towards to study.

Ann self-reported that she is “good at math,” but she does not like to do the work. She indicated that she is “not big on school work and not motivated to do work in any environment.” Her attitude towards mathematics is confirmed by her scores on the first mathematics attitude survey, You and Mathematics. Her mathematics confidence score was 1.92, indicating that she felt somewhat confident in her mathematics abilities. However, her scores on math anxiety (2.75) and self-efficacy (2.42) were higher, which indicated that she did experience some math anxiety and that she had some doubts about
her capability to perform well and attain her goals in mathematics. Overall, her average mathematics attitude score was 2.36, which indicates that she lies somewhat on the fence, but is leaning towards a more positive attitude towards mathematics.

Her desire to be successful is demonstrated by the fact that last year she took the video version of Algebra I at AVHS, which is an independent correspondence course distributed in either a DVD or a VHS format. The student watches the video lesson, completes the assignment, and turns the assignment in to the overseeing teacher. The student may email or call the teacher for clarification and is invited, but not required, to attend the Centra sessions with the online students. Ann failed the video course. She felt that the video course was a poor format for her learning style because it lacked any social interaction.

The video course was messing with my head and that is the reason I didn’t do well. I was just focusing on what the teacher [in the video] was saying, but I needed more social interaction.

Ann’s repeated attempts to complete the Algebra I course successfully indicated her desire to succeed. She was also aware of the relevance of successfully completing Algebra I for her career goals.

I knew it wouldn’t be easy and it wasn’t. I just wanted to stay home and sleep late. Taking the course online let me sleep in and it will help me in graphing and layout of things to become a graphics designer.

Her understanding of the relevance of successfully completing Algebra I was consistent with her high scores on pre-relevance (4.0) that were administered in the You and Mathematics survey. Those who felt the strongest that the course was relevant would be expected to score a five on the survey in this area. Therefore, Ann’s score of four may suggest that she fully understands the relevance of algebra to her life and goals. Ann’s
score in pre-confidence (3.5) towards her online Algebra I course suggests that she had less confidence in her ability to do well in Algebra I than in mathematics in general. Both her overall mathematics attitude score (2.36) and her pre-motivation score (3.75) hovered in the mid-range of the scale (3), but in both cases she leaned towards a positive attitude and sense of motivation. These scores might suggest that Ann experienced some anxiety and discomfort with her mathematics abilities, and these scores may not be solely due to her self-report of indifference to school work in general.

Cindy

Table 6.3: Cindy’s Learner Profile

<table>
<thead>
<tr>
<th>Math Confidence</th>
<th>Math Anxiety</th>
<th>Math Self-Efficacy</th>
<th>Pre-Mathematics Attitude</th>
<th>Pre-Confidence</th>
<th>Pre-Relevance</th>
<th>Pre-Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.75</td>
<td>3.25</td>
<td>3.25</td>
<td>3.42</td>
<td>4.00</td>
<td>5.00</td>
<td>4.50</td>
</tr>
</tbody>
</table>

Cindy is a 15 year old Caucasian, who successfully completed 8th grade in a private school, but only managed a D average in her previous advanced 8th grade mathematics course. She is very active in both volunteer and military organizations. She is a member of the Air Force Junior ROTC, the local Civil Air Patrol, and the local Color Guard. Due to her sister’s diagnosis of autism, Cindy does volunteer work with children with autism. She is also very interested in a variety of sports. Her goals include acquiring her pilot’s license, attending a military college, and becoming either a military pilot or a member of the security forces in one of the armed forces organizations. She is specifically interested in the Navy, the Air Force, or the Marine Corp. During my interview with Cindy, it was very clear that she was very single-minded in her goals for such a young woman.
Cindy self-reported that she did not consider herself accomplished in mathematics. She felt that her issues with mathematics began in elementary school and have continued into her high school career.

Math was never been my strong suit. It still isn’t. It doesn’t matter if I am working a year ahead or a year behind, or at the right level—I can’t not comprehend it. It is my worse thing ever. It takes me forever to understand it. … In private school I was doing all advanced math. In that private school you are usually doing the work for the next year. So in 4th grade I would be doing 5th grade work, but it was a 4th grade course for that school. I lost touch with math in grade school. I did great in 1st and 2nd grade, but once I hit 3rd grade, it all blew up in my face.

Cindy’s first set of mathematics attitude scores all hovered around the mid-range score of 3. Her mathematics confidence score was 3.75. Since I used the range of 2.5 to 3.5 as a guide for considering a student as not being very sure of their attitude or perhaps even indifferent, I interpreted Cindy’s 3.75 as demonstrating more confidence in her ability in mathematics. However, her math anxiety and self-efficacy scores were both 3.25. Her overall mathematics attitude score was 3.42, which may suggest that she leaned to a less positive attitude towards mathematics in general. Based solely on her survey scores, one might assume that Cindy is somewhat indifferent to mathematics. However, her declaration that mathematics is not her “strong suit,” combined with her scores, leads one to believe that Cindy deals with some lack of confidence and self-efficacy in mathematics, which also reinforces that she experiences some underlying math anxiety as well.

Cindy has a strong desire to be successful in Algebra due to her career goals. She was well aware of the relevance of mathematics in preparing to become a successful pilot.
It will really help me in ground school. Ground school is form my pilot’s license and is all about mathematics. Getting my pilot’s license is probably the most difficult think I have to achieve my goals in the service. It takes about two years and it’s about a $4000 gig, so that is mainly my concern.

At the time of the interview, Cindy was already aware that she was not doing very well in her online Algebra I course. Due to her understanding of the relevance of completing Algebra I successfully, she was already developing a contingency plan to improve her understanding of the subject.

I do plan on somewhat retaking the course, or like not officially retaking the course, or maybe if I want to improve a transcript grade I will. But I’ll probably go through some tutoring over the summer to make sure that I am completely understanding so I can go to ground school and it won’t be so difficult and won’t be as rigorous as it normally is.

Her pre-relevance score (5.0) supported her strong understanding of the relevance of Algebra I to her career goals.

Cindy’s pre-confidence score for online Algebra I (4.0) was higher than her confidence score for mathematics in general (3.75). Her overall mathematics attitude average (3.42) indicated a poorer attitude towards mathematics in general than her overall motivation average score (4.50) associated with her online Algebra I course. Her motivation score was raised due to her understanding of the relevance of algebra and her confidence that she can succeed in online Algebra I. Even though Cindy had indicated that mathematics was not her “strong suit”, the question came to my mind as to why Cindy was not performing better in algebra since her overall motivation was quite high.

Pursuing an explanation to this question, I asked her why she decided to attend the virtual high school and if there was anything about the high school that she felt was contributing to her performance. She indicated that she had a C average most of the time in her
previous school, but that last year she became far more involved in her social life, which “ended up really hurting [her] in all aspects of school.”

My mom thought, if she could, if she could keep me at home she could take away all of my social life, I would concentrate more on school, which surprisingly has worked.

Cindy reported that she was supposed to be enrolled in a pre-algebra course rather than an Algebra I course, but AVHS did not offer pre-algebra. Consequently, even though she was highly motivated to perform well in Algebra I, she did not feel academically prepared for the course.

I had a D average most of last year. This is my first time to take algebra. I was supposed to be in pre-algebra, so being in Algebra I is way over my head and reflective of my grade. [AVHS] does not offer pre-algebra. They had some math applications course and I looked over the material and that was what I had in 8th grade. So I kinda like already knew it. … I do the homework but my quizzes don’t show that. I usually don’t comprehend.

Certainly, Cindy’s lack of academic preparation played a major role in her ability to succeed in algebra. However, Cindy’s overall attitude towards mathematics in general and her self-talk about how mathematics is not her “strong suit” may have also sabotaged her performance in her online Algebra I course. She freely admits that she is easily distracted and does not always participate in class.

A lot of the class participates in Centra. I usually don’t participate because I usually get distracted by something on my desk and I start fiddling with it, which is really the reason my mother pulled me out of my brick and mortar school—because I get distracted really easily.
Karen is repeating 9th grade after failing the year before and failing 8th grade. She is 16 years old and Caucasian. Karen reports that her favorite activity is to hang out with her dad because she really trusts him a lot and can tell him anything. She also enjoys singing, dancing, writing poems and music. She owns three dogs and four cats, and she reports that she loves animals. In the future, she wants to become either a veterinarian or a professional singer. Karen gives the impression of being very honest and open as is demonstrated in the self-profile she posted the first week of class.

I am 16…I’m supposed to be in 9th grade still but I guess I’m getting help with that…Yeah, I know you guys are probably thinking who would want anyone to know that you failed….Honestly, it don’t matter to me because I can still make up what I need to make up for the 9th grade year.

However, coupled with the fact that Karen failed 8th and 9th grade, her comment that “it don’t matter to me” could be interpreted as a somewhat cavalier attitude about school in general. It would be easy to make such an assumption since in the online classroom one does not have the same visual and auditory cues that one has in a face-to-face classroom. There is an inability to read the body language that provides additional information as to the person’s intentions. This shortcoming in online learning adds another variable that makes it difficult to fully understand the student’s attitudes for the teacher, the other students, and the researcher. During our interview I had the benefit of hearing her voice.
and verbal expressions. My impression of Karen was that she is not cavalier and is, in fact, a very open child who is at risk of not completing high school.

As with Ann and Cindy, Karen reports that she does not have a positive relationship with mathematics.

Math is not a great subject for me. I have always found it hard and I have always had problems understanding it.

Karen’s issues with mathematics were supported by her mathematics attitude scores. All of her scores were in the mid-range of 3. Her mathematics confidence score (3.08) may suggest that she is somewhat unsure of her ability to perform successfully in mathematics. Her math anxiety score was slightly higher at 3.33, indicating that she does experience some anxiety towards mathematics, although it is not an overwhelming problem. However, her mathematics self-efficacy score (2.50) might suggest some belief that she is able to attain her goals in mathematics, which is consistent with her belief that “[she] can still make up what I need to make up for the 9th grade year.” Karen’s overall mathematics attitude score (2.97) may suggest that she, like Ann, is sitting on the fence when it comes to how she feels about mathematics in general.

Last year Karen enrolled in the AVHS’s Algebra I video course and failed. She felt that the video version was easier and that she performed better in the course because it did not have as much homework as the online Algebra I course. However, she admitted that she failed the video version because she “did not do enough of the homework.” When asked why she decided to take the online Algebra I course she stated that it was her mother’s opinion that the online version might be easier than returning to the traditional classroom. Karen preferred to return to her regular school or if she were to continue at AVHS, she wanted take the video course over.
I took this course because my mom thought it would be easier for me than going back to a face-to-face school. I wanted to go back because I miss my friends and the interaction of a regular school. I wanted to take the video course again, but the school signed me up for the online course so that it would fit into my schedule. It wasn’t my choice.

She admitted that she expected that the online version would be hard but she thought she would do better. She maintains that she was not performing well because she perceives mathematics as a difficult subject and that she would do better in a regular classroom.

I expected the course to be hard because my sister took it last year. But I expected I would do better. I am less successful in this course than my other online courses because math is not a great subject for me. Face-to-face is better because there is less work and the teacher explains things step by step.

Karen’s insistence that she would do better in another learning environment is consistent with her motivation scores for an online Algebra I course. Her pre-confidence score was 3.0, which may suggest she did not have strong positive or negative feeling of confidence in her ability to be successful in her online Algebra I course. Although she never indicated in her interviews that she felt the course was relevant to her goals, she did score slightly higher on her pre-relevance score (3.50). Again, this is not a strong indicator in either direction on how she feels about the relevance of Algebra I, but the score may suggest that she leans towards a realization of the course’s relevance. Her overall motivation score was 3.25. Her scores might suggest that she is on the fence in terms of both her overall mathematics attitudes and her motivation to learn. The fact that she failed the last two years of school leads me to believe that her poor performance may be due more to her level of motivation than her overall mathematics attitudes.
Mike

Table 6.5: Mike’s Learner Profile

<table>
<thead>
<tr>
<th>Math Confidence</th>
<th>Math Anxiety</th>
<th>Math Self-Efficacy</th>
<th>Pre-Mathematics</th>
<th>Pre-Confidence</th>
<th>Pre-Relevance</th>
<th>Pre-Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.08</td>
<td>2.83</td>
<td>2.58</td>
<td>2.50</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
</tr>
</tbody>
</table>

Mike is a 14 year old Caucasian male student who successfully completed 8th grade and was advanced to 9th grade. Mike reported that he moved from another western state about four years ago and finds his current home city “ok, but not [his] favorite place.” He enjoys riding his bike and scooters with his neighbors and playing paintball. His life goals include going to college and working in engineering or architecture in the future.

Mike appeared to be shy and reserved in his interactions with his classroom peers and with me during our interviews. I continually had to encourage him to elaborate on his answers. This shyness was evidenced by the fact that he did not post his profile in the classroom for others to read. Mike seemed to have some issues with socialization with his peers. His socialization issues may be due to an uncomfortable incident from 7th grade that led him to travel across the country to live with his aunt and attend school in another state.

In 7th grade I went to [Midwestern state] to live with my aunt and go to school there because some of the kids who live a couple of minutes away from me and going to the school— was hanging with me, but at first they were nice and then they started ganging and stuff. And I went to [Midwestern state] and did my whole 7th grade there and then I came back here and did the first part of 8th grade here. And then went back to [Midwestern state] to do the last part of 8th grade, and I was going to go back this year but I decided I didn’t want to.

Mike reports that “he is not really good at it [mathematics], but once [he] gets the stuff, [he] can do it. In the beginning it’s a little bit hard.” In the past he has taken regular
mathematics and pre-algebra. He self-reported that he passed those classes but there is no record of his grades and he did not volunteer any specific information pertaining to grades. Mike’s overall mathematics attitude score was 2.50, which may suggest that despite his concerns for his abilities in mathematics he leans towards a positive attitude towards mathematics in general. His mathematics confidence score (2.08) may suggest that he also feels more confidence in his ability to perform well in mathematics, in general, than he is willing to admit. Although his math anxiety score (2.83) is not dramatic, it might suggest some level of math anxiety that may influence his belief in himself since his mathematics self-efficacy score was 2.58. Perhaps his confidence score is representative of his belief that once he “gets it, [he] can do it.”

Mike is motivated to be successful, as indicated by his willingness to change states to stay focused on his school work. When he returned to his home district he initially went back to his home school and indicated that the classes were “Ok.” However, once again, he found himself uncomfortable in his regular school. The school services the north side of the city and Mike described that area of the city as “kinda bad or something.” Consequently, Mike decided to attend AVHS.

I went to the school I am zoned for and the classes were Ok, but I didn’t really like a lot of the kids that go there. Where I live it’s nice, but I guess a lot of the kids that go to that school are from the north part and I guess that part is kinda bad or something. And a lot of them don’t like it if you look at them, or something—so I didn’t want to be part of that so I decide to do school online.

When asked whether he felt uncomfortable or unsafe at his home school he responded that he was uncomfortable.

I was uncomfortable. I mean I don’t have a problem being with people it’s just when, you know, they look at you funny because you looked at them or something and you didn’t even say something and they be mad and stuff. It just didn’t feel very comfortable there.
For Mike, AVHS became a sanctuary where he felt comfortable and buffered from a school world that became a major distraction to his academics. He is considering continuing at AVHS, but is considering a new traditional high school that is opening next year. Either way, he has clear goals to pass his online Algebra I course and move on to higher mathematics.

I just want to pass and go to the next level, because I just want to go to the next level because the higher levels is where there is better stuff to do.

Mike’s realization that his Algebra I course is highly relevant to his future goals is supported by his high pre-relevance score of 4.0. His pre-confidence score is also high (4.0). The average of his motivation scores (4.0) is indicative of a young man who wants to succeed and has some solid confidence in his ability to succeed in an online Algebra course despite the possible presence of some math anxiety.

Sherry

Table 6.6: Sherry’s Learner Profile

<table>
<thead>
<tr>
<th>Math Confidence</th>
<th>Math Anxiety</th>
<th>Math Self-Efficacy</th>
<th>Pre-Mathematics Attitude</th>
<th>Pre-Confidence</th>
<th>Pre-Relevance</th>
<th>Pre-Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.50</td>
<td>4.08</td>
<td>3.92</td>
<td>4.17</td>
<td>3.00</td>
<td>3.50</td>
<td>3.25</td>
</tr>
</tbody>
</table>

Sherry is a 15 years old Caucasian girl who was repeating 9th grade. She self-describes herself as being into “stuff” of which the other students at AVHS were not interested.

Most of them aren’t really in my scene too much it seemed like. They didn’t like most of the stuff I did so they didn’t really peak my interest….People were like shocked by the way I am. See I used to have a mohawk and I shaved it off at the beginning of the year and it was REALLY long…and like..at the open house thingy…I had really short red and black hair, and piercings and patches and junk.
In both her class profile and in our interview\textsuperscript{12}, she relayed the most recent story of her life.

I originally went to [my regular] high school but I left that school to go to Any Home School\textsuperscript{13}, when after three weeks I ran away to [a southern state] to be with my boyfriend and was then arrested and taken to [a] juvenile delinquents center. I was then taken back home after two weeks.

She indicated that she could not return to the Any Home School because she had missed more than the two days permitted by the school and that the “virtual high school was [her] last option…besides public school.” Sherry wants to attend beauty school after she graduates from high school. She realizes that she must graduate from high school to accomplish her goal of attending beauty school.

I decided to keep myself out of trouble—to start going to school online where I wouldn’t decide to ditch or what not. If I want the job I need to work for it.

She admits that she has trouble with school in general and that she hates mathematics. Last year Sherry enrolled in and failed the first term of Algebra I A before she ran away from home. Due to her running away, she never completed the second semester of the course.

I am bad in school no matter what the program. Because I can pay attention for like the first few weeks. Then I get used to it and get distracted. I hate math…more than anything in the world!!!!! I took all the regular math classes and bombed every year, but some how would pass by the end of the school year barely.

In terms of Sherry’s admission that she is easily distracted, it should be noted that while Sherry was taking this online course she was also responsible for watching over her little brother during the day, which naturally added to her distractions.

\textsuperscript{12} Sherry’s interview was conducted through Centra’s Text Chat function because her microphone was not working. Her spelling errors were not corrected.

\textsuperscript{13} Sherry’s home schooling experience was with a specific organization. A pseudonym has been provided to protect the identity of the actual school.
Sherry’s mathematics attitude scores tell the same story. Her mathematics confidence score was 4.50. Her level of math anxiety was revealed with a score of 4.08 and her mathematics self-efficacy was 3.92. Averaged together her overall mathematics attitude score was 4.17. Sherry really does have unquestionable issues with mathematics in general.

Her motivation scores tell another story that is difficult to reconcile with her mathematics attitudes. Her pre-confidence score was 3, which may suggest she is unsure of her confidence, but she has more confidence in her ability to be successful in her Algebra I course than in mathematics in general. Her pre-relevance score was 3.5, which might suggest that she is on the fence, but still leaning to the positive side, in terms of how relevant she feels her online Algebra I course is to her accomplishing her goals. Combining her motivation scores gave her an overall motivation score of 3.25, which may suggest that she is not overly sure of her motivation towards her online Algebra I course. However, it may suggest a stronger level of motivation towards her online Algebra I course than for mathematics in general. Since Sherry realizes that she wants to attend beauty school and that if she wants the job she will have to work for it, her motivation may show this internal determination, albeit not an overwhelming high level of determination. There were only two statements that were asked about confidence in the first survey, You and Mathematics. One of the statements said, “Whether or not I succeed in Algebra I is up to me.” Sherry’s high pre-confidence score and her realization that she has “to work for it” supports that she may really believe that her success in Algebra I is up to her.
Maria

Table 6.7: Maria’s Learner Profile

<table>
<thead>
<tr>
<th>Math Confidence</th>
<th>Math Anxiety</th>
<th>Math Self-Efficacy</th>
<th>Pre-Mathematics Attitude</th>
<th>Pre-Confidence</th>
<th>Pre-Relevance</th>
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<td>2.25</td>
</tr>
</tbody>
</table>

Maria was the only Latino student of the student participants. She is 16 years old and is in the 10th grade. Maria did not complete a class profile in WebCT. Therefore, neither her peers nor her teacher had any information that would enable them to get to know Maria prior to the beginning of the course. In her interview she gave the impression of being somewhat disinterested and her answers were rarely of any length. She did have a younger brother in the same class as she, but he withdrew from the class prior to the end of the semester and did not participate in the study. During the interview, Maria indicated that she liked just hanging out with her friends, music, and singing. As for a career, she said she might like to be a “singer or something.”

Yeah, I guess I like to do stuff with my friends. I like music and singing and maybe I will become a singer or something.

Maria confessed that she did not like mathematics, or school in general. She indicated the courses in which she did well were in non-academic subjects such as Glee Club, Beginning Guitar, and the Army ROTC. Although overall, she had performed better the prior year, allowing her to advance to 10th grade, she did not pass Algebra I. In fact, she had taken Algebra I twice in the past two years and had not passed either time. This was confirmed by her district academic records, as well. This year was her third attempt to pass the course.
I just don’t seem to be able to pass. I guess I just don’t like school in general. I like, I can do OK or even good in some subjects, but math is just something I really hate. At first I did pretty well in things like the school’s Army ROTC and I like music so I did ok in things like the Glee Club and guitar. But this is, like, my third time to take Algebra. I really don’t like it—like, I hate math.

Maria’s seemingly disinterested attitude towards school, especially mathematics, was supported by her mathematics attitude scores and her motivation scores. Since she had tried twice before this year to pass Algebra I, it is not surprising that her mathematics confidence score was 4.33, indicating she has no confidence in her ability to perform well in mathematics. Her level of math anxiety was very high at 4.83 and her mathematics self-efficacy score was 4.08. Although Maria did not openly admit to having any anxiety, it appears from her scores that math anxiety plays a major role in her lack of confidence. Her overall mathematics attitude score was 4.42.

I had the impression that she was not any more motivated to work harder at AVHS than at her traditional school. According to Maria, it was her mother that thought she and her brother might do better in an online school. Maria said that she misses the interaction with her friends at school, even though she “ditched” classes a lot. Her records showed that she was absent more often in all of her academic classes, but, for example, never missed her ROTC Drill/Leadership course.

I wanted to go back to my regular school because I like hanging with my friends. I mean, I ditched a lot with my friends and I guess that didn’t help me get great grades, yeah—I didn’t think I wanted to go to [AVHS], that was my mother’s idea. She thought we might not be distracted if we were at home.

Maria’s motivation scores are aligned with her mathematics attitude. She neither sees Algebra I as relevant nor does she have any appreciable confidence in her ability to perform well in Algebra I. Her pre-relevance score was 2.5, which may suggest that she definitely leans to the negative side of the mid-line. Her pre-confidence score was only a
2.0. Consequently, when averaged, her overall motivation score was only 2.25, indicating that she has little sense of motivation towards her online Algebra I course.

Table 6.8: Susan’s Learner Profile

<table>
<thead>
<tr>
<th>Math Confidence</th>
<th>Math Anxiety</th>
<th>Math Self-Efficacy</th>
<th>Pre-Mathematics Attitude</th>
<th>Pre-Confidence</th>
<th>Pre-Relevance</th>
<th>Pre-Motivation</th>
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</thead>
<tbody>
<tr>
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<td>5.00</td>
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<td><strong>4.50</strong></td>
</tr>
</tbody>
</table>

Susan is an African-American, 14-year-old girl who was successfully promoted to the 9th grade. In her online profile she said that she is devoted to her church and sings on the praise team. She practices on Saturdays, and attends church on Wednesdays and Sundays. In our interview she revealed that she is on the AVHS student council, which keeps her busy with planning special social events for the virtual high school students. She is also involved in a local NAACP program for students to compete for scholarships and awards. She loves to sing, dance, and read. Ultimately, she plans on attending college and becoming a pediatrician.

Although there was no documentation available from the district, Susan self-reported that she took the entire year of Algebra IA and did well. She is very enthusiastic about mathematics.

Math is my favorite subject. I took last year Algebra IA, which is a pre-algebra course and I did really well in that course. I really like algebra and math. I plan to take Algebra II next year.

Susan’s mathematics attitude scores confirm her love of mathematics. She has a high sense of confidence in performing well in mathematics with her mathematics confidence score of 1.0. Her math anxiety score was 1.17 and her mathematics self-efficacy score
was 1.50, indicating that she experiences little math anxiety and she believes in her ability to perform well in mathematics to accomplish her goals. Susan’s overall mathematics attitude score (1.22) indicated that she has the most positive attitude towards mathematics of any of the other students participating in the study.

Susan’s motivation scores correspond tightly with her mathematics attitudes. When I asked her why she chose AVHS and if she planned on returning next year, her response provided a clear indication of how highly motivated she is to increase her knowledge.

At my middle school we got a lot of Katrina victims. They came to our school and so our class kinda was put on hold and we had to like bring the other students up to our level, so I didn’t really get to expand my knowledge that well. I plan to stay at [AVHS] all through high school. I prefer the independence of being online.

Susan’s pre-confidence score (5) was the highest in the group, which may suggest that she has considerable more confidence in her ability to be successful in her online Algebra I course than do her peers. Her pre-relevance score (4.0) is in line with her goals and overall attitude. Susan’s overall motivation score (4.50), which is in concert with her overall mathematics attitude score (1.50) may suggest that she had a very positive attitude towards not only mathematics, but also her online Algebra I course.

Kendra

Table 6.9: Kendra’s Learner Profile

<table>
<thead>
<tr>
<th>Math Confidence</th>
<th>Math Anxiety</th>
<th>Math Self-Efficacy</th>
<th>Pre-Mathematics Attitude</th>
<th>Pre-Confidence</th>
<th>Pre-Relevance</th>
<th>Pre-Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.58</td>
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<td>4.00</td>
<td><strong>4.50</strong></td>
<td>3.00</td>
<td>3.50</td>
<td><strong>3.25</strong></td>
</tr>
</tbody>
</table>

Kendra is African-American. She is 15 years old and was repeating the 9th grade. Kendra was also a member of the AVHS Student Council. She recently moved to the
north side of the city from a small town on the east coast. The story behind Kendra’s 9th grade status is one that demonstrates the issues students face when they move mid-year or very near the end of the year, as Kendra had. Kendra self-reported that she should be in 10th grade but she was held back because she moved from the east coast before taking the state test, which would allow her to be promoted to the next grade. Upon arriving to her new home and district, her credits were not accepted.

I’m in 9th grade, but I am supposed to be in 10th grade—because I failed only because I was supposed to take the state test and I couldn’t because I left to come here so, so that is why I have to do 9th grade all over again…I was doing alright [in her former school courses]. I wasn’t the best, but I was doing well enough to pass. I mean they just said for me to take it over again to see how I am doing and we’ll take it from there.

The district did not have Kendra’s former school records, so there was no way to verify Kendra’s story, but it leaves me with a troublesome question. Was Kendra held back because of some perception of her academics or for another reason, such as an assumption due to her race?

Despite her initial problems with the school district, she grew to like her new city “because there are more opportunities—like if you want to become somebody because it’s a bigger city.” In both her class profile and her interview she said she liked to dance, sing, and act. She indicates that others have praised her singing ability and that she would like to make a career from her abilities and “be somebody.”

Kendra said she didn’t like mathematics and that it was very hard for her. She reported that she had taken and passed a full year of Algebra I on the east coast. However, she was receiving special one-on-one help. Since moving to her new district
she has not received any special consideration. The lack of special attention has left her shy and withdrawn in class for fear of appearing “stupid.”

I took fractions. I took Algebra I. I mean I was doing a little good in algebra because the teacher was going one-on-one with me. Then I moved up here and then the teacher, I think she is really good, but I just don’t understand because my learning skills are different from hers. So it’s hard to like try to combine them together.

My learning skills are slower and I try to catch up with her [Mrs. Smith] sometimes but then its going to fast and I get nervous and everybody’s in the class and I get really shy and like being embarrassed because I have to ask the question again. That’s always been me. I’ve always been pretty shy because I didn’t want anybody to make me feel stupid.

Following up on Kendra’s shyness and fear of appearing “stupid”, I asked her if this fear was the reason she enrolled in AVHS.

June: So the reason you took the online class was so you wouldn’t have to be in a regular class where people might not think you are as smart as you would like them to think you are?

Kendra: Yeah, I thought it was going to be one-on-one, but then I saw everyone in class so—Oh My God, how am I going to do this?

Kendra reported that she became accustomed to the online format and the presence of the other students in the class and admitted that she would be just as shy in a regular classroom.

I feel it’s alright now because I got used to it. I’m still shy though and I am trying to open up a little. And if I had to go to a regular school I’d probably get confused sometimes, but I’d ask sometimes but I would not do it in a way that, like after class or something.

Although Kendra reported that she had passed Algebra I in her former school, she was still uncertain about the online Algebra I content and admitted she had difficulty keeping up with the class instruction. It would appear that there was something missing in this story. Perhaps Kendra passed Algebra I, but just barely. Or perhaps she was
successful with the one-on-one instruction but still did not retain the content. The fact that she was receiving one-on-one instruction in her former Algebra I course indicates that she may have had an IEP that was not passed along to her new district or that she was in some other special arrangement.

Kendra’s mathematics survey scores told a similar story; a young girl who has difficulty with mathematics. Her significant lack of confidence in her ability to perform well in mathematics was seen in her mathematics confidence score of 4.58. Similarly, her math anxiety score (4.92) and her mathematics self-efficacy score (4.0) might suggest that she suffers from significant anxiety and lacks the belief in her ability to perform well in mathematics to accomplish her goals. Kendra’s overall mathematics attitude score (4.5) indicated she experiences a very negative attitude towards mathematics.

Initially, Kendra’s expectations for attending AHVS were not very high, but then she became motivated to be successful in her online Algebra I course because she really wanted to “make something better for [her] life.”

I thought that it was going to be boring and I though it was going to be terrible. Because at first I didn’t really want to go to this school, but I thought about it and thought well if I could get myself to really work and do thinks instead of hanging out with my friends and everything—always getting in trouble—maybe I could just change and make something better for my life and that’s how I ended up being in this school but I really have been upset a few times about it.

There were a variety of factors that could have affected Kendra’s new found motivation to learn in her online Algebra I course. First, she was held back without any documented reason other than the fact she did not have a chance to take the state test in her former state. Second, she was very shy and withdrawn in class. Third, she clearly felt she needed more individual attention to succeed and she was not receiving such attention from the district or school. She had attempted to exchange emails with Mrs. Smith to fill in the
gaps, but then she reported that she was experiencing serious family problems that led her
to shut down.

Lately I haven’t [emailed Mrs. Smith] because I’ve had a family problem and I’ve
been shutting down on things. I mean, when I started I was like emailing her all
the time, then I just shut down because I was at home with a big family problem.
I’ve just been trying to clear all the stress from my head and um..just stay in my
room and do my work. But the problem just keeps getting bigger and bigger, so
it’s kinda scary.

Despite all of the negatives in Kendra’s personal and academic life, her motivation scores
might suggest that she was not totally unmotivated towards her online Algebra I course.
All of her motivation scores were in the mid-range of the scale. Her overall motivation
score was 3.25, which may suggest that she was not very sure of her sense of motivation
at the time she completed the first survey. Her pre-confidence was 3.0 and her pre-
relevance score was 3.5. Given her reports of lack of confidence in mathematics in
general, one might even expect poorer motivation scores that would certainly be in
alignment with her overall mathematics attitude scores. However, Kendra did admit that
it was up to her to change to better her life, so perhaps her mid-range scores reflect that
attitude.

Sally

Table 6.10: Sally’s Learner Profile

<table>
<thead>
<tr>
<th>Math Confidence</th>
<th>Math Anxiety</th>
<th>Math Self-Efficacy</th>
<th>Overall Math Attitude</th>
<th>Pre-Con</th>
<th>Pre-Relev</th>
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</tr>
</thead>
<tbody>
<tr>
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<td>4.17</td>
<td>2.50</td>
<td>3.50</td>
<td>3.00</td>
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</table>

Sally is Caucasian, 15 years old, and a 9th grader due to failing last year. She was
an AVHS student last year as well. Like Maria, Sally was not very forthcoming in her
interviews with me or in her profile on WebCT, although she did post a profile. It took
several attempts by email and telephone calls to get her to follow through with her obligations in the study. She would miss a deadline, apologize after I would call her, and then she would miss the next deadline. In her profile and in her first interview with me, she reported that she liked to hang out with her friends, watch movies, and listen to music: what she refers to as “normal teenage stuff.” She hasn’t given thought to her career goals at this time.

This is my second year at [AVHS] since I failed everything last year. I like doing normal teenage stuff, like hangin’ with my friends and watching movies. And, like, I like music, too. You know—the normal stuff.

Sally was repeating Algebra I from the year before. She indicated that it wasn’t because she didn’t attend the Centra sessions, although she missed five sessions, but rather that she just didn’t do the work. She admits hating mathematics, but she also admitted that she isn’t motivated to do well in school. She would rather “hang with [her] friends.” Her records show that the only classes she did not fail last year were Computer Literacy and Study Skills. The impression I gathered from my interactions with Sally was that she had difficulty with following up with her obligations. She gave me the impression that she was totally disinterested and I could not break down the barrier she had built to understand her better.

I failed Algebra I last year, so that’s why I have to repeat it. I did Ok in Computer Literacy, but that is easy, ‘cause you either pass or fail and its pretty hard to fail. And I got an A in Study Skills, but you kinda just have to show up for that. It wasn’t that I skipped class all that much, but I just never did the work. I am just not into school. It is pretty easy to get distracted and just go hang with my friends.

Sally’s overall mathematics attitude score (4.17) supported her dislike of mathematics. Her scores might suggest a young girl who has little confidence in her ability to perform well in mathematics (3.83). Her mathematics self-efficacy score (4.33) supports the same
conclusion: she does not have a belief in her ability to accomplish her goals through performing well in mathematics. Although she did not say that she experienced any math anxiety, her math anxiety (4.33) score might suggest that she experiences a high amount of anxiety.

Like Maria, Sally gave me the impression that she was not motivated to do any school work, not just mathematics. Her grades from the previous year certainly hinted to her indifference to school in general. However, she attended class even though it seemed as if she knew she was not going to do the required work to pass the class. When asked why she took the online Algebra I course last year and repeated the same format this year, she indicated that she had difficulty paying attention in school. She thought if she attended AVHS maybe she would focus better and pass her classes.

Me and my mother decided I could try going to [AVHS] because I wasn’t doing very well in my regular school. I would daydream and just not pay attention. Doing it online let me sleep during the day and just hang out and then I could do my work at night—it works better for me and I thought I’d do more in the weekend.

Her overall motivation score was right in the middle of the scale at 3.0. This score represents a balance between her pre-confidence score of 2.5 and her pre-relevance score of 3.5. Her pre-confidence score essentially tells the same story as her mathematics confidence score; she has very little confidence in her ability to perform well in mathematics in general or an online Algebra I course. However, she does seem to have some understanding of the relevance of taking Algebra I, but the question still remains if she sees the relevance only because it is a required course to graduate since she did not articulate any strong career goals at this time.
Table 6.11: Kim’s Learner Profile

<table>
<thead>
<tr>
<th>Math Confidence</th>
<th>Math Anxiety</th>
<th>Math Self-Efficacy</th>
<th>Pre-Mathematics Attitude</th>
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</thead>
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<td>4.50</td>
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<td><strong>4.50</strong></td>
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</tbody>
</table>

Kim is 15 years old. She is a Caucasian 9th grader who was held back from promotion to 10th grade due to not having enough credits. She reported that her parents moved often and that she was originally from the west, had moved to the mid-west, and then back to the west. Both in her WebCT profile and her interview with me, she reported that she liked singing, dancing, browsing the Internet and “chillin’ with [her] friends.” She is also active in her local church and performs community service projects through the church. Her career goals include going to college to become an interior or fashion designer. She hopes someday to own her own business in design and become a designer to the stars. Kim very specifically mentioned that she also wanted to get married and have some children. Kim was outgoing and eager to help in this study.

I want to go to college and I want to become an interior or fashion designer. I am not sure what schools yet. I plan on getting married and having some children. And maybe someday owning my own business in design and maybe someday becoming a designer to the stars. That would be cool. I want to make a lot of money.

When asked about her experience in mathematics, she provided her rendition of what it is like to move between states.

Well, um, I was in—I’ve taken math my whole life. I didn’t really start getting into algebra until 4th grade and I didn’t really understand it much. It’s different in every school system in different states. When I moved [here] I was 8th grade. In [her previous state] I’d been in mathematics and didn’t start taking math until 7th grade. I started taking pre-algebra in 7th grade in [her previous state] and then moved to [here] in 8th grade, and took a lower math—I didn’t take pre-algebra. Last year I took Algebra I A—kinda like what I am taking now, but it takes longer.
because it a full year and then you are supposed to take Algebra IB, which is kinda like Algebra I second semester. Now I am taking Algebra I.

Kim did complete Algebra I A in her previous 9th grade year with a D. When I asked for a clarification, she verified that she skipped Algebra I B and enrolled in Algebra I, a higher level course. When asked what she thought of mathematics, she said she liked mathematics. She admitted that at first the material in her online Algebra I course was easy, but it was becoming harder and her teacher was explaining the content “really well.” Kim wants to continue into the higher mathematics courses, especially geometry.

The first two months—fairly easy because I already knew it fairly well—because I had already knew the material. But later in the class it got a little bit harder, but the teacher explained it really well. … Yeah, I like math. When I get this over with, I want to take the upper math classes. I think I want to go into geometry.

Kim’s mathematics attitude scores support her enjoyment of mathematics in general. She is reasonably confident as indicated by her mathematics confidence score of 2.00. Her mathematics self-efficacy score (2.83) suggests that her belief in her ability to accomplish her goals in mathematics was weak. Perhaps her level of self-efficacy is affected by her math anxiety (2.5), which is low, but existent. Averaged together, her overall mathematics attitude score was 2.44, which points to a positive overall attitude.

Kim is motivated to do well in her online Algebra I course due to her health problems that make it difficult to attend a regular school. She states that the online class experience has worked out “perfectly well” for her and is “kinda cool.”

Well, um, last year I was having a lot of health problems and I still am and I get sick a lot. We decided online school so when I am deftly ill I can continue to do my work and not be behind. I’m doing pretty well. I like taking it online because you can go back and look at the slides. It’s kinda cool to be in an online environment, um…It’s kinda like a regular class—you don’t know what anybody looks like but… its cool because everyone likes everyone.
Kim’s overall motivation score was 4.5, indicating her overall high level of motivation towards her online Algebra I course. Her pre-confidence (4.5) suggests that she was very confident in her ability to perform well in her online Algebra I course. Her pre-relevance scores (4.5) demonstrated that she understands that Algebra I is important to her career goals in her life.

**Summary of Learner Profiles**

With the small sample size of 10 students, it is difficult and perhaps inappropriate to define specific learner groupings. However, there are some similarities and differences among these 10 students that should be noted. There was only one male student, one Latino student, and two African-American students. Given these numbers, there was not enough data to make any conclusions based on gender or race.

Half of the students were repeating 9th grade, either due to failing 9th grade last year (Karen, Sherry, and Sally) or due to special circumstances (Kendra and Kim). Five students had overall mathematics attitude scores that indicated somewhat indifferent attitudes, with scores ranging from 2.36 to 3.42. Four students’ overall mathematics attitudes suggested a dislike for mathematics in general, with scores ranging from 4.17 to 4.5 (Sherry, Maria, Kendra, and Sally). One student, Susan, was the only student who had a very positive attitude towards her mathematics abilities. Figure 6.1 presents the overall mathematics attitude scores for each student. I chose the score range from 2.5 to 3.5 as indicating that the student’s overall attitude was in the range of indifference or not sure, although I gave consideration to the student’s self-reporting during the interviews as well.
I considered the student to be leaning towards a poor mathematics attitude if the student’s score was higher than 3.5. Any student with an overall score lower than 2.5 was considered to lean towards a positive mathematics attitude.

The range of overall motivation scores was not as spread out among the 10 students (see Figure 6.2). Maria possessed the least amount of overall motivation towards the online Algebra I course with a score of 2.25. Three students had a score of 4.50 (Cindy, Susan, and Kim), one student scored 4.0 (Mike), and one student scored 3.75 (Ann). Each of these five students had high pre-relevance scores and they self-reported that they understood the high relevance of taking Algebra I to accomplish their goals, and their high motivation to take it online.
Figure 6.2: Student Pre-Motivation Scores

All of the students in this study initially entered this online Algebra I course with some expectation that an online course would improve their chances of doing well. Based on the students’ previous experiences in mathematics and school in general, as told through both quantitative and qualitative data, I considered nine of these students to be at-risk for poor outcomes. Susan was the only student that came to the course with an obvious potential for success.

Student’s Attitudes towards the Four Constructs

In this sub-section the quantitative data from the surveys administered at the end of the course semester are reported. The results of the surveys provided quantitative data that were used to determine the students’ mathematics attitudes and their motivation to learn, and the students’ perception of transactional distance and social presence within the course. Qualitative data are reported in relationship to the quantitative data to provide
a clearer picture of the students’ experiences in an online Algebra I course. For the students’ mathematics attitudes and motivations to learn, the percent change was calculated and presented to provide a picture of how the students’ attitudes changed from the beginning to the end of the semester. The students’ academic performance in the class is also reported and discussed in light of the four constructs of this study.

**Mathematics Attitudes**

To quantify the percent changes in mathematics attitudes over the course of the semester, the raw scores from the second administration of the mathematics attitude survey (B) were subtracted from the raw scores of the first administration of the mathematics attitude survey (A). That figure was then divided by the second raw mathematics survey score (B) and then multiplied by 100 to determine the percent change (see Figure 6.3).

$$\left(\frac{A - B}{A}\right) \times 100 = \% Change$$

Figure 6.3: Equation for calculating percent change in mathematics attitude scores

For example, if the student’s first mathematics confidence score was 1.50, indicating a high level of confidence, and the second mathematics confidence score was 1.95, then the percent change would be -23.0%, which might suggest that the student’s confidence to perform well in mathematics declined 23.0%. This interpretation is because a lower score on the mathematics attitude survey (i.e., 1) indicates a more positive attitude than a higher score (i.e., 5). Therefore, an initial confidence score of 1.50 indicates that the student experienced more confidence in performing well in mathematics than the student experienced at the end of the semester with a mathematics confidence score of 1.95.
The CIS motivation scale is just the opposite of the mathematics attitude scale. The number one represents less motivation than the number five. Therefore, if the same equation was used to determine the percent change in pre-confidence and pre-relevance, the signs (- or +) would be just the opposite of the mathematics attitude percent change. To avoid this confusion, the equation was altered to ensure the results would have the appropriate signs (see Figure 6.4). For example, if the student’s pre-relevance score was 3.50 and then was 3.00 after the semester, then the percent change in student’s Relevance would be -14.3%. The negative percent change represents a decline in the student’s attitude towards the relevance of the course.

\[
\left( \frac{B - A}{A} \right) \times 100 = \% \text{Change}
\]

Figure 6.4: Equation for calculating percent change in CIS motivation scores.

The Group

Table 6.12: Passing and Failing Students’ Post-Mathematics Attitudes

<table>
<thead>
<tr>
<th>Average Scores</th>
<th>Passing Students</th>
<th>Failing Students</th>
<th>Survey Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-Mathematics</td>
<td>2.10</td>
<td>3.68</td>
<td>1 = positive attitude</td>
</tr>
<tr>
<td>Attitudes</td>
<td></td>
<td></td>
<td>5 = negative attitude</td>
</tr>
</tbody>
</table>

The averages of the post-mathematics attitude raw scores (see Table 6.12) suggest that the passing students appeared to have a greater positive attitude (2.10) towards mathematics than the failing students (3.68) after the completion of the course. However, the percent changes for the group suggests the group experienced a decline in its overall mathematics attitude by 1.06%. Table 6.13 summarizes each student’s and the group’s pre- and post-mathematics attitude scores and includes the percent changes in these scores and the students’ first quarter and final grades. When analyzed as a group, the
group’s mathematics confidence and the group’s self-efficacy declined by 1.49% and 5.45%, respectively. The first quarter grade average for the entire group was 40.10%. By the end of the semester, the final grade average for the group declined by 15.62% to an overall final grade average of 34.64%. Interestingly, the group’s math anxiety improved by 3.22%, which does not appear to be an overwhelming improvement. None of these percent changes seem to represent an overall positive or negative statement about the course and as such the instruction and course design did not appear to have a positive impact on the students’ mathematics attitudes. Although individual students’ results varied, for most the percent changes were not dramatic.

**Motivation**

This discussion presents the group’s level of motivation based on relevance and confidence since there are pre- and post- scores available to help determine how the group’s attitudes may have changed over the duration of the course. After the discussion on relevance and confidence a summary the group’s attitude towards attention and satisfaction, the average ARCS score will be provided.

Table 6.15 summarizes the percent change of each student’s pre- and post-relevance and confidence scores, as well as the percent change in each student’s overall level of motivation from the beginning to the end of the course. These scores were compiled from four statements taken from the entire Course Interest Survey (CIS). These four statements were included in the first administration of the mathematics attitude survey to create an initial baseline of the student’s level of motivation as it relates to relevance and confidence. The answers to these same statements were used in the CIS at the end of the course to determine if there was a change in the student’s motivation.
Table 6.13: Pre- and Post Mathematics Attitude Scores, Percent Changes, and Course Grades

<table>
<thead>
<tr>
<th>Name</th>
<th>Pre-Confidence</th>
<th>Post Confidence</th>
<th>% Chg Confidence</th>
<th>Pre-Math Anxiety</th>
<th>Post Math Anxiety</th>
<th>% Chg Math Anxiety</th>
<th>Pre-Self-Efficacy (Effectance)</th>
<th>Post Self-Efficacy (Effectance)</th>
<th>% Chg Self-Efficacy</th>
<th>Pre-Mathematics Attitude Average</th>
<th>Post Mathematics Attitude Average</th>
<th>% Chg Ave. Mathematics Attitudes</th>
<th>1st Quarter Grade</th>
<th>Final Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ann</td>
<td>1.92</td>
<td>1.50</td>
<td>21.74</td>
<td>2.75</td>
<td>1.67</td>
<td>39.27</td>
<td>2.42</td>
<td>2.17</td>
<td>10.21</td>
<td>2.36</td>
<td>1.78</td>
<td>24.61</td>
<td>62.1% D</td>
<td>26% F</td>
</tr>
<tr>
<td>Cindy</td>
<td>3.75</td>
<td>3.25</td>
<td>13.33</td>
<td>3.25</td>
<td>3.50</td>
<td>-7.69</td>
<td>3.25</td>
<td>3.58</td>
<td>-10.15</td>
<td>3.42</td>
<td>3.44</td>
<td>-0.78</td>
<td>60.0% D</td>
<td>51.5% F</td>
</tr>
<tr>
<td>Karen</td>
<td>3.08</td>
<td>4.00</td>
<td>-29.73</td>
<td>3.33</td>
<td>4.58</td>
<td>-37.40</td>
<td>2.50</td>
<td>3.25</td>
<td>-30.00</td>
<td>2.97</td>
<td>3.94</td>
<td>-32.67</td>
<td>26.6% F</td>
<td>10.8% F</td>
</tr>
<tr>
<td>Mike</td>
<td>2.08</td>
<td>2.25</td>
<td>-8.00</td>
<td>2.83</td>
<td>3.00</td>
<td>-5.88</td>
<td>2.58</td>
<td>3.33</td>
<td>-28.90</td>
<td>2.50</td>
<td>2.86</td>
<td>14.40</td>
<td>63.4% D</td>
<td>62.2% D</td>
</tr>
<tr>
<td>Sherry</td>
<td>4.50</td>
<td>4.42</td>
<td>1.78</td>
<td>4.08</td>
<td>3.75</td>
<td>8.16</td>
<td>3.92</td>
<td>3.75</td>
<td>4.26</td>
<td>4.17</td>
<td>3.97</td>
<td>4.64</td>
<td>5.0% F</td>
<td>7.3% F</td>
</tr>
<tr>
<td>Maria</td>
<td>4.33</td>
<td>4.75</td>
<td>-9.62</td>
<td>4.83</td>
<td>4.67</td>
<td>3.38</td>
<td>4.08</td>
<td>4.25</td>
<td>-4.08</td>
<td>4.42</td>
<td>4.56</td>
<td>-3.17</td>
<td>2.0% F</td>
<td>10.7% F</td>
</tr>
<tr>
<td>Susan</td>
<td>1.00</td>
<td>1.08</td>
<td>-8.00</td>
<td>1.17</td>
<td>1.50</td>
<td>-28.57</td>
<td>1.50</td>
<td>1.92</td>
<td>-28.00</td>
<td>1.22</td>
<td>1.50</td>
<td>-22.73</td>
<td>83.1% B</td>
<td>85.0 B</td>
</tr>
<tr>
<td>Kendra</td>
<td>4.58</td>
<td>4.50</td>
<td>1.82</td>
<td>4.92</td>
<td>4.50</td>
<td>8.47</td>
<td>4.00</td>
<td>3.92</td>
<td>2.00</td>
<td>4.5</td>
<td>4.31</td>
<td>4.30</td>
<td>12.6% F</td>
<td>5.2% F</td>
</tr>
<tr>
<td>Sally</td>
<td>3.83</td>
<td>3.92</td>
<td>-2.26</td>
<td>4.33</td>
<td>3.50</td>
<td>19.23</td>
<td>4.33</td>
<td>3.92</td>
<td>9.54</td>
<td>4.17</td>
<td>3.78</td>
<td>9.28</td>
<td>4.8% F</td>
<td>9.3% F</td>
</tr>
<tr>
<td>Kim</td>
<td>2.00</td>
<td>1.92</td>
<td>4.00</td>
<td>2.50</td>
<td>1.67</td>
<td>33.20</td>
<td>2.83</td>
<td>2.25</td>
<td>20.59</td>
<td>4.00</td>
<td>1.94</td>
<td>20.36</td>
<td>80.9% B-</td>
<td>78.4% C+</td>
</tr>
<tr>
<td>Class Average</td>
<td>3.11</td>
<td>3.16</td>
<td>-1.49</td>
<td>3.40</td>
<td>3.23</td>
<td>3.22</td>
<td>3.14</td>
<td>3.23</td>
<td>-5.45</td>
<td>3.37</td>
<td>3.21</td>
<td>-1.06</td>
<td>40.10%</td>
<td>34.64%</td>
</tr>
</tbody>
</table>

A positive percent change indicates that the student’s post-score was less than the student’s previous score reported earlier in the course. For Confidence and Self-Efficacy, a positive change equals an increase in confidence. For Math Anxiety, a positive change equals a decrease in math anxiety. Lower scores suggest a more positive experience with mathematics. Scale: 1= Strongly Agree; 2= Agree; 3= Neutral/Don’t Know; 4= Disagree; 5= Strongly Disagree
These scores from the four statements in the CIS were referred to in this study as the students’ post-relevance and post-confidence scores. The statements were:

1. I feel confident that I will do well in Algebra I. (Confidence)
2. Whether or not I succeed in Algebra I is up to me. (Confidence)
3. To accomplish my goals, it is important that I do well in this class. (Relevance)
4. I do NOT think I will benefit much from this class. (Relevance)

At the end of the course the entire Course Interest Survey was administered and analyzed (see Table 6.16). The CIS provided a detailed analysis of each student’s perception of the specific course (i.e., online Algebra I) in terms of the ARCS model, which addresses the concepts of:

1. Attention: Did the course design and/or the teacher instruction gain the attention of the student? Did the course stimulate curiosity and interest?
2. Relevance: Was the course or instruction perceived by the students as relevant to their goals? Did the instruction link the content to the students’ needs and interests?
3. Confidence: Did the course affect the student’s confidence to perform well in the course? Did the instruction promote self-efficacy and positive expectations?
4. Satisfaction: Did the instruction provide reinforcement that positively affected the students’ level of satisfaction with their learning experience?

In both tables the higher numbers represent a positive response. For example, a score of 5 for relevance means that the student felt the course was very relevant.
The results from the pre- and post scores for relevance and confidence, and the scores from the full CIS are discussed. To avoid confusion about which score is being reported, it is important to remember that the terms: pre-relevance, pre-confidence, post-relevance, post-confidence, pre-motivation average, and the post-motivation average are scores that were generated using only the four statements from the Course Interest Survey and may be viewed on Table 6.15 and Figure 6.5. The CIS scores will be referred to as the CIS relevance, CIS confidence, CIS attention, and CIS satisfaction, CIS ARCS (the total score) and these scores may be viewed on Table 6.16 and Figure 6.6

The Group

Table 6.14: Passing and Failing Students Average CIS ARCS Score

<table>
<thead>
<tr>
<th>Average Scores</th>
<th>Passing Students</th>
<th>Failing Students</th>
<th>Survey Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>4.22</td>
<td>2.58</td>
<td>1 = less motivation</td>
</tr>
<tr>
<td>(Average CIS ARCS)</td>
<td></td>
<td></td>
<td>5= more motivation</td>
</tr>
</tbody>
</table>

As a group, the percent change from the pre- and post-motivation average scores (see Table 6.15 and Figure 6.5) did not change (0%). There was no change in the group’s perception of the relevance of their online Algebra I (0%) or their level of confidence (0%). Consequently, the overall average motivation score for the group did not change (0%). The scores might suggest that, as a group, there was no change in terms of their perceptions of the course in relation to the four basic questions asked at the beginning and the end of the course.

Table 6.16 and Figure 6.6 report the results of the full CIS that was administered at the end of the course. The average score for each of the four components of the ARCS model ranged from 2.79 to 3.35. The lowest average score, 2.79, was concerned with the
perception of the students that the course and instruction gained their attention. The lower score may suggest that the students were not overly impressed with the ability of either the course design or the instruction to increase their attention. The average satisfaction score was 3.02, which may suggest that the course was moderately satisfying to the group as a whole. These scores might suggest that as a group the course design and instruction did not impact the group’s motivation to learn during the course.

The group’s average CIS ARCS score was 3.10, which corresponds to a “moderately true” response in the survey. However, the averages of the CIS ARCS raw scores (see Table 6.14) suggest that the passing students appeared to more motivation (4.22) than the failing students (2.58) after the completion of the course. It might be speculated that the failing students’ motivation was affected by the inability of the course design and instruction to attract the attention of the failing students.

![Figure 6.5: Pre-Motivation, Post-Motivation, and Average CIS ARCS scores for each student](image)

Figure 6.5: Pre-Motivation, Post-Motivation, and Average CIS ARCS scores for each student
Table 6.15: Percent Change from Student’s Pre- and Post-Motivation Scores and Course Grades

<table>
<thead>
<tr>
<th>Name</th>
<th>Pre-Relevance**</th>
<th>Post Relevance**</th>
<th>% Chg</th>
<th>Pre-Confidence*</th>
<th>Post Confidence*</th>
<th>% Chg</th>
<th>Pre-Motivation Average</th>
<th>Post Motivation Average</th>
<th>% Chg</th>
<th>1st Quarter Grade</th>
<th>Final Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ann</td>
<td>4.00</td>
<td>4.00</td>
<td>0</td>
<td>3.50</td>
<td>4.50</td>
<td>28.57</td>
<td>3.75</td>
<td>4.25</td>
<td>13.33</td>
<td>62.1%</td>
<td>D</td>
</tr>
<tr>
<td>Cindy</td>
<td>5.00</td>
<td>5.00</td>
<td>0</td>
<td>4.00</td>
<td>4.00</td>
<td>0</td>
<td>4.50</td>
<td>4.50</td>
<td>0</td>
<td>60.0%</td>
<td>F</td>
</tr>
<tr>
<td>Karen</td>
<td>3.50</td>
<td>3.00</td>
<td>-14.29</td>
<td>3.00</td>
<td>2.00</td>
<td>-33.33</td>
<td>3.25</td>
<td>2.50</td>
<td>-23.08</td>
<td>26.6%</td>
<td>F</td>
</tr>
<tr>
<td>Mike</td>
<td>4.00</td>
<td>4.50</td>
<td>12.50</td>
<td>4.00</td>
<td>3.50</td>
<td>-12.50</td>
<td>4.00</td>
<td>4.00</td>
<td>0</td>
<td>63.4%</td>
<td>D</td>
</tr>
<tr>
<td>Sherry</td>
<td>3.50</td>
<td>3.50</td>
<td>0</td>
<td>3.00</td>
<td>2.50</td>
<td>-16.67</td>
<td>3.25</td>
<td>3.00</td>
<td>-7.69</td>
<td>5.0%</td>
<td>D</td>
</tr>
<tr>
<td>Maria</td>
<td>2.50</td>
<td>1.50</td>
<td>-40.00</td>
<td>2.00</td>
<td>2.00</td>
<td>0</td>
<td>2.25</td>
<td>1.75</td>
<td>-22.22</td>
<td>2.0%</td>
<td>F</td>
</tr>
<tr>
<td>Susan</td>
<td>4.00</td>
<td>5.00</td>
<td>25.00</td>
<td>5.00</td>
<td>5.00</td>
<td>0</td>
<td>4.50</td>
<td>5.00</td>
<td>11.11</td>
<td>83.1%</td>
<td>B</td>
</tr>
<tr>
<td>Kendra</td>
<td>3.50</td>
<td>3.50</td>
<td>0</td>
<td>3.00</td>
<td>3.00</td>
<td>0</td>
<td>3.25</td>
<td>3.25</td>
<td>0</td>
<td>12.6%</td>
<td>F</td>
</tr>
<tr>
<td>Sally</td>
<td>3.50</td>
<td>3.00</td>
<td>-14.29</td>
<td>2.50</td>
<td>3.00</td>
<td>20.0</td>
<td>3.00</td>
<td>3.00</td>
<td>0</td>
<td>4.8%</td>
<td>F</td>
</tr>
<tr>
<td>Kim</td>
<td>4.50</td>
<td>5.00</td>
<td>11.11</td>
<td>4.50</td>
<td>5.00</td>
<td>11.11</td>
<td>4.50</td>
<td>5.00</td>
<td>11.11</td>
<td>80.9%</td>
<td>B-</td>
</tr>
<tr>
<td>Group Averages</td>
<td>3.80</td>
<td>3.80</td>
<td>0</td>
<td>3.45</td>
<td>3.45</td>
<td>0</td>
<td>3.63</td>
<td>3.63</td>
<td>0</td>
<td>40.1%</td>
<td>34.6%</td>
</tr>
</tbody>
</table>

Higher relevance scores suggest the student perceived the course to be relevant to the goals. Higher confidence indicates a greater sense of confidence in performing well in Algebra I. Scale: 1= Not True; 2= Slightly True; 3= Moderately True; 4= Mostly True; 5= Very True

*Confidence Scores are based on two statements from the CIS Survey: “I feel confident that I will do well in Algebra I.” and “Whether or not I succeed in Algebra I is up to me.” A negative percent change indicates the student’s confidence was lower at the end of the course.

**Relevance Scores are based on two statements from the CIS Survey: “To accomplish my goals, it is important that I do well in this class.” and “I do NOT think I will benefit much from this class.” A negative percent change indicates the student perceived the relevance of the course as less at the end than at the beginning.
Karen was one of the failing students who did not find the course satisfactory. Her CIS attention score was only 2.13 and her CIS satisfaction score was very low at 1.67.

In our interview, Karen had definite opinions as to what affected her level of satisfaction with the course.

I was hoping that the teacher would explain more and use step-by-step instructions. The course is too hard and there is too much homework. The Easy Algebra is easy, but the rest is too hard. The discussions in WebCT make it easier, but there isn’t anything else in it that helps. Centra is cool but there is too much waiting so it gets boring. Kids end up talking too much or too long and the session lasts more than an hour, which is too long.

Cindy, another failing student, reinforced what appeared to be a problem with gaining the attention of the students.

I usually don’t participate because I usually get distracted by something on my desk and I start fiddling with it…

The passing students reported more satisfaction with the course and felt the course grabbed their attention. However, Mike, a passing student, had scores that were not entirely consistent with the other passing students’ scores or with the impression I received of his attitude he during his interviews. His CIS ARCS score (3.53) was in the neutral zone, which might suggest that he was not very motivated by the course. Mike’s CIS attention (3.13) and satisfaction score (3.22) were also moderate. Yet, he did indicate that he liked the teacher and the Centra sessions because you couldn’t hear any chatter in the background like one might in a regular classroom.

Well, it’s a pretty good course. The teacher does a pretty good job. The kids are nice. So it makes it easier to learn. Because it is online you don’t have to wait. Like when you are in a regular class some kids might be talking and you might miss what the teacher said. But online you can’t hear that they are talking until they press the button, so you can hear better and learn better.
Table 6.16: Student’s End-of-Course Motivation based on ARCS using the CIS Survey and Course Grades

<table>
<thead>
<tr>
<th>Name</th>
<th>Attention</th>
<th>Relevance</th>
<th>Confidence</th>
<th>Satisfaction</th>
<th>ARCS</th>
<th>1st Qtr Grade</th>
<th>Final Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ann</td>
<td>3.38</td>
<td>3.8</td>
<td>4.75</td>
<td>4.33</td>
<td>4.08</td>
<td>62.1% D</td>
<td>26% F</td>
</tr>
<tr>
<td>Cindy</td>
<td>2.13</td>
<td>4</td>
<td>2.63</td>
<td>3.56</td>
<td>3.12</td>
<td>60% D</td>
<td>51.5% F</td>
</tr>
<tr>
<td>Karen</td>
<td>2.13</td>
<td>2</td>
<td>2.5</td>
<td>1.67</td>
<td>2.06</td>
<td>26.6% F</td>
<td>10.8% F</td>
</tr>
<tr>
<td>Mike</td>
<td>3.13</td>
<td>4</td>
<td>3.75</td>
<td>3.22</td>
<td>3.53</td>
<td>63.4% D</td>
<td>62.2% D</td>
</tr>
<tr>
<td>Sherry</td>
<td>3.13</td>
<td>2.78</td>
<td>2.75</td>
<td>1.67</td>
<td>2.38</td>
<td>5% F</td>
<td>7.3% F</td>
</tr>
<tr>
<td>Maria</td>
<td>1.88</td>
<td>1.44</td>
<td>2.25</td>
<td>1.67</td>
<td>1.79</td>
<td>2% F</td>
<td>10.7% F</td>
</tr>
<tr>
<td>Susan</td>
<td>4.38</td>
<td>4.78</td>
<td>5</td>
<td>5</td>
<td>4.79</td>
<td>83.1% B</td>
<td>85% B</td>
</tr>
<tr>
<td>Kendra</td>
<td>1.88</td>
<td>3.22</td>
<td>2.38</td>
<td>2</td>
<td>2.38</td>
<td>12.6% F</td>
<td>5.2% F</td>
</tr>
<tr>
<td>Sally</td>
<td>2.5</td>
<td>2.56</td>
<td>2.75</td>
<td>2.22</td>
<td>2.5</td>
<td>4.8% F</td>
<td>9.3% F</td>
</tr>
<tr>
<td>Kim</td>
<td>3.36</td>
<td>4.11</td>
<td>4.75</td>
<td>4.88</td>
<td>4.35</td>
<td>80.9% B-</td>
<td>78.4% C+</td>
</tr>
<tr>
<td>Group Average</td>
<td>2.79</td>
<td>3.27</td>
<td>3.35</td>
<td>3.02</td>
<td>3.10</td>
<td>40.10%</td>
<td>34.60%</td>
</tr>
</tbody>
</table>

Higher attention scores suggest the course/teacher gained the attention of the student. Higher relevance scores suggest the student perceived the course to be relevant to the goals. Higher confidence indicates a greater sense of confidence in performing well in Algebra I. Satisfaction increases with the higher number, as well. Higher ARCS scores suggest a higher level of motivation. Scale: 1= Not True; 2= Slightly True; 3= Moderately True; 4= Mostly True; 5= Very True.

In addition, even though Mike did pass the course, he chose to retake the course in the spring, which gave me the impression that he was motivated to achieve in the course or he would have simply moved on to another course rather than attempt to improve his grade. Due to this type of inconsistency, in retrospect, the CIS should have been administered at both the beginning and the end of the course to understand fully any
changes in the individual’s and group’s motivation to learn over the duration of the course, rather than only using four sentences that were out of context of the complete survey.

Figure 6.6: Course Interest Survey ARCS scores (1-5)

Transactional Distance and Social Presence

To understand the students’ perceptions of the amount of transactional distance and social presence that was associated with the class and instruction, two surveys were administered at the end of the semester. Transactional distance is considered to be a function of pedagogy rather than geography. The distance perceived by the online student is often a function of the interaction within the class. For this study, the following interactions were surveyed and analyzed.

- Student to Interface (TDSI)
• Student to Teacher (TDST)
• Student to Student (TDSS)

The survey also included questions that provide a lens into how the students perceived the distance in the course overall (TD). Table 6.18 presents the data from the Transactional Distance Survey. Scores that lie between 2.5 and 3.5 are considered neutral or moderate for both transactional distance and social presence. It is the degree of difference that was considered to develop an interpretation.

To understand if there were differences in the students’ perceptions of social presence between WebCT and Centra, the Social Presence Survey was expanded to have the same questions repeated for each learning environment. Social presence represents the “ability of the participants to project their personal characteristics into the community, thereby presenting themselves to the other participants as ‘real people’” (Garrison, Anderson, and Archer, 2000, p. 89). Table 6.18 also presents the data from the Social Presence Survey.

The Group

Table 6.17: Passing and Failing Students Transactional Distance and Social Presence Scores

<table>
<thead>
<tr>
<th>Average Scores</th>
<th>Passing Students</th>
<th>Failing Students</th>
<th>Survey Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD Student-Interface</td>
<td>1.71</td>
<td>2.61</td>
<td>1 = less TD perceived</td>
</tr>
<tr>
<td>TD Student-Teacher</td>
<td>1.44</td>
<td>2.34</td>
<td>5 = more TD perceived</td>
</tr>
<tr>
<td>TD Student-Student</td>
<td>2.28</td>
<td>2.80</td>
<td></td>
</tr>
<tr>
<td>TD (Student-Course)</td>
<td>1.48</td>
<td>2.80</td>
<td></td>
</tr>
<tr>
<td>Total Transactional Distance</td>
<td>1.73</td>
<td>2.64</td>
<td></td>
</tr>
<tr>
<td>SP in WebCT</td>
<td>2.56</td>
<td>2.94</td>
<td>1 = more SP perceived</td>
</tr>
<tr>
<td>SP in Centra</td>
<td>2.18</td>
<td>2.71</td>
<td>5 = less SP perceived</td>
</tr>
<tr>
<td>Total Social Presence</td>
<td>2.37</td>
<td>2.83</td>
<td></td>
</tr>
</tbody>
</table>
As a group, the students’ scores suggest that the amount of transactional distance was low in every interaction category (see Table 6.18 and Figure 6.7). The group’s transactional distance score (TD) for the course was 1.57. The other averaged scores ranged from 1.33 to 2.13, with the lowest transactional distance occurring in the interaction between the student and the teacher (TDST). This may suggest that the students in general felt they had access to Mrs. Smith and received timely interaction with her. The score for the perceived distance between the student and the interface was 2.13. Since this was the highest score for the group, there is the possibility that the group perceived the course’s interface a bit difficult, which might increase the students’ perception of transactional distance.

The average scores of each of the transactional distance categories suggests that the failing students perceived more transactional distance than the passing students upon completion of the course (see Table 6.17). The passing students’ average TD score was 1.73 and the failing students’ average TD score was 2.64, which might suggest that the passing students perceived that there was less psychological distance than did the failing students. This may further suggest that the failing students experienced a greater perception of isolation and difficulty within the course.

The group’s perception of social presence suggests that the group did not have a strong sense of “knowing” each other during the class. When the social presence in the WebCT and Centra environments were averaged together the average social presence in the course was 2.69 (see Table 6.18). Using the same criteria (2.5 to 3.5) for determining a range of scores that represent a neutral response, this score may suggest that the students, as a group, did not have a strong negative or a positive perception of social
presence in the course. However, the average score for Centra was lower than the average score for WebCT by 11%. Since Centra is a synchronous communication environment, it might make sense that the students, in general, would perceive that Centra had a higher level of social presence (see Figure 6.8). The all of students could hear each other, see each other raise their hands, and exchange text-chats in the background. One student complained about a malfunctioning microphone. That student could not always speak. However, the student could text-chat her questions and answers. This technical difficulty may or may not have affected these students’ perception of social presence. This was not addressed in the analysis and is a limitation of the study. WebCT as an asynchronous learning environment might naturally be perceived as possessing less social presence unless concerted effort was made in the design of the course to compensate for the lack of real-time interaction. The differences between the failing and the passing students’ perceptions of social presence were small (see Table 6.17). Even though the differences were small, the scores did suggest that the failing students may have perceived less social presence in the course than did the passing students. This pattern was consistent between the social presence in WebCT and in Centra.

Figure 6.7: Transactional Distance Scores for WebCT and Centra
Both transactional distance and social presence can be a function of how much effort the course participants put into the course. If a student did not attend a course it would not be surprising that the student would feel isolated from the other students and have a sense that a great chasm exists between themselves and every facet of the course. The course was 17 weeks long. Consequently, there were 17 Centra sessions and at least 17 opportunities to post a response to the WebCT discussion forum. Students received 10 for each Centra session they attend and 10 points for each posting in WebCT. No specific number of posts in WebCT was required, However, students who missed three sessions of Centra were considered truant and received an F in the course just as they would if they were attending a traditional classroom. The class average for postings to WebCT was only 9.9 posts and the average attendance for Centra was only 11.9 sessions. The class average was reduced by the very poor participation by the failing students. The failing students averaged only 5.29 WebCT discussion posts, whereas the passing students averaged 20.67 discussion posts. The failing students’ attendance averaged
10.29 sessions. The passing students attended 15.67 sessions on average (see Table 6.20). Despite this low participation in the course by some of the students, their perception of transactional distance was surprisingly lower than I might expect. Perhaps if the students had participated more frequently the students’ perception of distance might be even lower. The low participation in the course does provide a reasonable explanation as to why the social presence scores were at best neutral. If the students had participated more the scores for social presence might be lower, indicating a greater sense of social presence.

Table 6.18: Social Presence and Transactional Distance Survey Results

<table>
<thead>
<tr>
<th>Name</th>
<th>Ave. SP WebCT</th>
<th>Ave. SP Centra</th>
<th>TDSI</th>
<th>TDST</th>
<th>TDSS</th>
<th>TD</th>
<th>1st Quarter Grade</th>
<th>Final Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ann</td>
<td>2.46</td>
<td>2.08</td>
<td>2.13</td>
<td>1.33</td>
<td>2.09</td>
<td>1.57</td>
<td>62.1%</td>
<td>D</td>
</tr>
<tr>
<td>Cindy</td>
<td>3.0</td>
<td>2.31</td>
<td>2.13</td>
<td>2.33</td>
<td>2.27</td>
<td>2.14</td>
<td>60.0%</td>
<td>D</td>
</tr>
<tr>
<td>Karen</td>
<td>3.0</td>
<td>3.23</td>
<td>2.75</td>
<td>2.67</td>
<td>3.18</td>
<td>3.29</td>
<td>26.6%</td>
<td>F</td>
</tr>
<tr>
<td>Mike</td>
<td>3.0</td>
<td>2.54</td>
<td>2.38</td>
<td>1.67</td>
<td>2.55</td>
<td>1.86</td>
<td>63.4%</td>
<td>D</td>
</tr>
<tr>
<td>Sherry</td>
<td>2.85</td>
<td>2.92</td>
<td>3.13</td>
<td>2.17</td>
<td>3.00</td>
<td>3.14</td>
<td>5.0%</td>
<td>F</td>
</tr>
<tr>
<td>Maria</td>
<td>3.92</td>
<td>3.46</td>
<td>3.13</td>
<td>2.83</td>
<td>3.55</td>
<td>3.86</td>
<td>2.0%</td>
<td>F</td>
</tr>
<tr>
<td>Susan</td>
<td>2.31</td>
<td>2.31</td>
<td>1.25</td>
<td>1.33</td>
<td>2.55</td>
<td>1.14</td>
<td>83.1%</td>
<td>B</td>
</tr>
<tr>
<td>Kendra</td>
<td>2.92</td>
<td>2.46</td>
<td>2.75</td>
<td>3.20</td>
<td>3.36</td>
<td>3.29</td>
<td>12.6%</td>
<td>F</td>
</tr>
<tr>
<td>Sally</td>
<td>2.46</td>
<td>2.54</td>
<td>2.25</td>
<td>1.83</td>
<td>2.18</td>
<td>2.29</td>
<td>4.8%</td>
<td>F</td>
</tr>
<tr>
<td>Kim</td>
<td>2.38</td>
<td>1.69</td>
<td>1.50</td>
<td>1.33</td>
<td>1.73</td>
<td>1.43</td>
<td>80.9%</td>
<td>B</td>
</tr>
<tr>
<td>Class Averages</td>
<td>2.83</td>
<td>2.55</td>
<td>2.13</td>
<td>1.33</td>
<td>2.09</td>
<td>1.57</td>
<td>40.1%</td>
<td>34.6%</td>
</tr>
</tbody>
</table>

Social Presence Scale and Transactional Distance Scale: 1= Strongly Agree, 2= Agree, 3= Not Sure/Neutral, 4=Disagree, 5= Strongly Disagree. The lower the score for TD, the lower the level of transactional distance perceived by the student (a positive outcome). The lower the score for SP, the higher the level of social presence is perceived by the student (a positive outcome.)

TDSI= Student/Interface Interaction; TDST= Student/Teacher Interaction; TDSS= Student/Student Interaction; TD= Student overall perception of transactional distance in the course.
Summary of Student’s Attitudes towards the Four Constructs

The purpose of this section was to understand if the motivation to learn, mathematics attitudes, and perceptions of transactional distance and social presence of secondary students enrolled in a virtual high school Algebra I course in an e-learning environment were related to the students’ learner profiles and their mathematics achievement. To answer this question, the students responded to four surveys that gathered information about each of the four constructs; motivation, mathematics attitudes, transactional distance, and social presence. The Mathematics Attitude Survey was administered before and after the completion of the course. Four motivation questions were isolated from the Course Interest Survey and added to the first administration of the Mathematics Attitude Survey to provide a baseline on each student’s level of motivation as they entered the course. The surveys on transactional distance, social presence, and the Course Interest Survey were administered at the end of the semester. Student activity was measured using the number of times a student entered WebCT (hits), posted a response in WebCT’s discussion forum, and attended the Centra classroom sessions. Student demographics were collected during the first survey, through school records and self-reported information from the students. In addition to this quantitative data, interviews were conducted with the students and the teacher that gave participants an opportunity to tell their story about their background and their experiences in the course. In each sub-section specific to one of the constructs, both the quantitative data and the qualitative data were reported. In this summary, the post-mathematics score, the ARCS score, and the average scores for transactional distance and social presence were calculated and used as the final measurements (See Table 6.19).
The number of participants in this study did not allow for performing predictive statistical analyses. Consequently only descriptive statistics were performed. However, using the descriptive statistics gathered during the study and the interview data from the students some potential patterns may be considered among the four constructs and the students’ academic achievement. The observation of these patterns does not suggest causation. In addition, the patterns speculated in these results are based on specific differences between the passing and failing students as individual groups rather than as individuals. Evaluated as individuals, there were some exceptions to the patterns speculated here.
Generally, those students who passed the course, Mike, Susan, and Kim, were similar in terms of the four constructs and their participation in the course. The passing students participated regularly in the course, with the exception that Kim only posted in the WebCT discussions four times. This was consistent with Kim’s negative attitude about the interaction in WebCT. With the exception of Ann and Cindy, those students who failed the course were also similar among themselves in terms of the four constructs and course participation (see Table 6.19). Ann’s participation in WebCT was very high based on her number of hits. However, those hits occurred primarily at the beginning of the course when she expressed motivation to pass the course. By the end of the course, Ann had chosen to not participate not only in the course but in school in general. Cindy was always motivated to do well in the course and was simply not successful. Her motivation is evidenced by her participation in the course and her choosing to retake the course the following semester.

There appeared to be a potentially strong relationship between the students’ mathematics attitude and their final grades (see Table 6.20 and Figure 6.9). Those students with poorer mathematics attitudes received either a D or an F in the class. The lone exception to this observation was Ann. Ann’s mathematics attitude was very positive, yet she failed the course. Ann was on the path to pass the course at the end of the first quarter, but then she stopped participating and doing her work. Mike passed that class, but only with a D and his mathematics attitude was in the neutral zone of 2.5 to 3.5. Susan and Kim, who also passed, possessed very positive attitudes about mathematics and they both passed with a grade above a C.
Table 6.20: Average Scores, Participation Statistics, and Grades for Passing and Failing Students

<table>
<thead>
<tr>
<th>Average Scores</th>
<th>Passing Students</th>
<th>Failing Students</th>
<th>Survey Scale Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Attitudes</td>
<td>2.10</td>
<td>3.68</td>
<td>1 = positive attitude 5 = negative attitude</td>
</tr>
<tr>
<td>Motivation (ARCS)</td>
<td>4.22</td>
<td>2.58</td>
<td>1 = less motivation 5 = more motivation</td>
</tr>
<tr>
<td>Transactional Distance Average</td>
<td>1.73</td>
<td>2.64</td>
<td>1 = less TD perceived 5 = more TD perceived</td>
</tr>
<tr>
<td>Social Presence Average</td>
<td>2.37</td>
<td>2.83</td>
<td>1 = more SP perceived 5 = less SP perceived</td>
</tr>
<tr>
<td>WebCT Visits</td>
<td>320</td>
<td>187.70</td>
<td>Potentially strong relationship</td>
</tr>
<tr>
<td>WebCT Discussion Posts</td>
<td>20.67</td>
<td>5.29</td>
<td>Potentially Weak relationship</td>
</tr>
<tr>
<td>Centra Attendance</td>
<td>15.67</td>
<td>10.29</td>
<td></td>
</tr>
<tr>
<td>Final Grade</td>
<td>75.2%</td>
<td>13.83%</td>
<td></td>
</tr>
</tbody>
</table>

Figure 6.9: Final Grades, ARCS, and Mathematics Attitude
With the exception of Ann, those students with scores that suggested that they possessed a lot of motivation (ARCS score) were also the only students who passed (see Figure 6.9). Susan, Kim, and Mike were the passing students. Mike’s final grade was only a D. His ARCS score was borderline (3.53), albeit on the higher side of the neutral zone. Since Mike signed up to retake the class in the spring to raise his grade, one might speculate that he was more motivated than his ARCS scores suggested.

There did not appear to be a lot of difference between the passing students’ perception of social presence and the failing students’ perceptions. Although the passing students appeared to have more motivation and higher achievement, the fact that there was not a large difference in the two group’s social presence scores leads one to speculate that there was not a strong relationship between the students’ perception of social presence and their motivation or achievement (see Table 6.20). Figure 6.11 also suggest a random pattern of the social presence scores in relation to the ARCS scores exists. Despite this lack of a strong relationship, there appeared to be a stronger relationship between social presence and transactional distance among the passing students (see Figure 6.11). This led me to speculate if there may be a stronger relationship between social presence and motivation that was less observable due to the low numbers of students in the study.

There appears to be a stronger relationship between the students’ perceptions of social presence and their mathematics attitudes (see Figure 10). Eighty percent of the students appeared to have experienced a relationship between the social presence scores and their mathematics attitude.
I suggest that there may be a pattern evidenced between the students’ perception of transactional distance and their mathematics attitudes. The passing students possessed more positive attitudes towards mathematics and perceived less transactional distance. However, only 50% of all the students’ experienced higher transactional scores with higher mathematics attitudes scores.

Figure 6.10: Mathematics Attitudes, Social Presence, Transactional Distance and ARCS

It might also be speculated that there was a pattern between the perception of transactional distance and motivation (ARCS), as well as between motivation and mathematics attitudes (see Figure 6.10). With the exception of Ann, those students with lower motivation to learn tended to perceive a greater transactional distance in the course. Four failing students, Karen, Sherry, Maria, and Kendra, exhibit this trend. However, Cindy and Sally, also failing students, had lower motivation but their perception of transactional distance was below 2.5, potentially suggesting that they perceived less transactional distance in the course. However, the spread between Cindy’s and Sally’s
transactional distance scores and their motivation scores was not very wide (see Table 6.18). Cindy’s ARCS score was 3.12 and her TD average was 2.22. The spread between those scores was only 0.90 points. Sally’s ARCS score was 2.5 and her TD average was 2.14, the spread was only 0.36 points. In contrast, those students with high motivation and low perceptions of transactional distance had greater point spreads between their ARCS score and their TD average. Susan’s ARCS score was 4.79 and her TD average was 1.57, so the spread was 3.22 points. Kim’s spread was 2.85 and even Mike’s spread, who I considered borderline on motivation, was 1.42.

This difference in point spread between motivation and transactional distance scores leads on to consider if there was a relationship between how a student perceives transactional distance in a course and her motivation in the course. When transactional distance and motivation are compared with the students’ final grades, the students who passed were the same students who possessed high motivation and perceived low transactional distance in the course (see Figure 6.12). Again, Ann was the exception.

![Figure 6.11: Transactional Distance, Social Presence, and ARCS](image)
Figure 6.13 graphically represents the potential relationships that I speculate exist between the students’ mathematics attitudes, motivation to learn, and their perceptions of transactional distance and social presence, and their final grades. The one way arrows suggests that the data supports a one way affect and the two way arrows suggests the potential for a cycle, whether positive or negative. The dotted arrow suggests that the data was very weak in supporting a relationship, but logic might suggest that there could a stronger relationship. With the little quantitative data available, forming strong support for these relationships and patterns, is not possible and future research is needed to confirm the potential statistical significance of these relationships, if any, in an e-learning secondary Algebra I course.
What was it about Ann that was different? Her scores suggest that she was motivated, perceived less transactional distance and high social presence in the course, and had a positive mathematics attitude, and still she failed. Ann seemed most interested in becoming a graphics designer and she understood the relevance of taking Algebra I to achieve that goal. She said she was good at mathematics, which might explain why her mathematics attitude score was positive. However, she admitted that she did not like going to school or doing the work. In my attempts to interview her, it was difficult to get her to follow through, and the same was true for getting her to complete the surveys. I had to keep calling and emailing to remind her to follow through on her obligations to the study. Ann had a D at the end of the first quarter and was participating, but by the end of the semester she had stopped participating and she failed the course. Perhaps Ann was everything her scores might suggest she was, but she just did not and would not do the work as she said in her interview.
Section II: Research Question II

How might the design, including the pedagogical practices, of a secondary virtual e-learning Algebra I course be described in light of existing principles of best practice in mathematics and a virtual learning high school environment?

The second question was answered by creating an evaluation model, the e-Learning Evaluation Tool for Algebra I Courses (e-LETAC), that provided a tool to evaluate the quality of the course systematically, including teacher quality, instructional design, and support systems. The e-LETAC (see Table 4.5) was created by blending the standards and guidelines recommended by the National Council for Teachers of Mathematics (NCTM), the Education Alliance, the National Education Association (NEA), and Southern Regional Education Board (SREB) into one comprehensive framework that served as the foundation of the evaluation model. The purpose of blending these resources was to create a content-specific evaluation tool for online courses, in this case Algebra I. To evaluate an online course fully, one must consider all the facets of that course, which include the design, the pedagogy, and the content.

The e-LETAC tool had six columns. The first column was divided into criteria categories: (1) teacher quality, (2) instructional design, and (3) support systems. Each category was sub-divided into specific areas of concern that were addressed by the tool. The second column represents the best practices for online virtual schools. The indicators were developed by identifying common criteria recommended by the NEA and by the SREB for online virtual school instruction and course development. The third column contains indicators developed from the NCTM and Education Alliance pedagogical standards and from the NCTM content standard for Algebra I at the eighth to ninth grade
level. Where there was an indicator that has several subordinate criteria, the subordinate criteria were identified by an alpha numeric character and the indicator represented the average of the subordinate scores. The fourth column lists the numbers that correspond to each indicator. The fifth column was the scoring area. There are three levels of performance represented by numbers, shown below. Zero was assigned if it was not possible to observe the indicator or information was unavailable to score the indicator. Indicators receiving a zero were not included in the final total score or calculation of the average score.

0 = information unavailable or unobservable

1 = does not meet the indicator

2 = partially meets the indicator, but needs some improvement

3 = meets the indicator, no improvements obvious

There were 101 indicators with a total possible score of 303, if every indicator met the criteria. In this first iteration of the e-LETAC tool, a comprehensive rubric was not developed. However, the indicators were in the form of a number list and each indicator was weighted evenly. The scoring was subjective and based on evidence gathered from the observation of the class in Centra and WebCT, the discussions, assignments and tests, the overall course structure and navigation, and the interviews with the teacher. If there was an indication that a concerted effort was being made by the developers, the school, or the teacher, the indicator was typically assigned a numerical value of 2 to provide the benefit of the doubt. In other words, if an indicator was partially met then the number 2 was assigned. In an effort to clarify an assigned score, the fifth column provided space for an explanation of the score.
This section is divided into four sub-sections. The first sub-section summarizes the evaluation results for the overall course. The next three sub-sections cover the results in greater detail for the three overarching criteria: teacher quality; instructional design; and support systems. Table 6.21 has the completed e-LETAC evaluation of the course. When evaluating the course content and teacher instructional practices, an expert in middle school and high school algebra content and standards, Dr. J. Yow, was consulted to verify that the ratings were correctly assigned based on how well the content and pedagogy followed standards-based mathematics teaching.

**The Course**

The total score for the AVHS online Algebra I course was 191.83 out of a possible score of 303 (see Table 6.21). Converted to a percentile, the course earned 63% out of 100% possible. The average score was 1.92. The teacher quality score was 1.88. The instructional design score was 1.88 and the support systems score was 2.13. This data indicated that the course had not met most of the indicators and had significant room for improvement (see Figure 6.14).

Figure 6.14: e-LETAC scores for each evaluation criterion
Teacher Quality

The average score for teacher quality was 1.88. The teacher quality scores are displayed in Figure 6.15. Mrs. Smith was well qualified in terms of state and district standards. She had a Bachelors of Science degree in teaching secondary mathematics and a Masters degree in curriculum and instruction. She taught secondary mathematics for eight years.

She was trained to teach online through the AVHS’ technology support team, but did not have formal outside training or a certification for online teaching. However, Mrs. Smith has taken some courses online and therefore has some experience as an online student. She has also attended some conferences pertaining to virtual schools. The district pays $22.00/hour for conference attendance, but does not provide substitutes. Consequently, if Mrs. Smith attends a conference during the semester, she must pre-record her Centra session for the classes she would miss. Her students would then access that week’s content by watching the play-back of the session without the benefit of her immediate presence to answer any questions.

Mrs. Smith’s teaching style was very traditional and did not adhere to the NCTM and Education Alliance recommended pedagogy. Her teaching style also did not exhibit the best practices recommended for virtual school teachers by the NEA or SREB. Her score for teacher preparation was 2.71, which was high, but still reflects the lack of extensive outside training for online teaching that she was not provided. This lack of training was also evident in her scores for online facilitation and assessment and activities, which were 1.33 and 1.58, respectively. However, Mrs. Smith was a reflective teacher who was open to learning and analyzing her practice. She was clear throughout
the study that she was very interested in sharing her story and learning from the research results.

Although there were some weaknesses indicated in her course preparation and organization, student progress monitoring, and technology policy and support, these areas were reasonably strong and would need only a few changes to raise her scores. In the preparation and organization area the score was lower due to the lack of awareness of the students’ prior academic experiences and ability levels. In examining the records, the district’s records have major gaps of information on many of the students enrolled in the course. Mrs. Smith said that if a student was doing poorly in class or performed poorly the previous year, a counselor will contact the student to discuss the available options for the student.

Figure 6.15: Teacher Quality Scores
Usually, we receive the student’s IEP if one exists and any records that may exist for the student. If the student did really bad in a normal school, the student does bad in the virtual school as well. If a student is doing poorly, the student’s counselor will contact the student and indicate that he/she might want to reconsider staying in [AVHS], but the counselor can’t ask the student to leave.

Mrs. Smith did not receive information from the school or district pertaining to any special needs or prior IEPs that might have traveled with her students during the study. The previous year was the first time Mrs. Smith taught Algebra I fulltime and she had not been warned of what to expect or what the backgrounds were of her students. She said she was shocked by the low pass rate in her class last year and decided to make a change. This year Mrs. Smith made a special effort to contact each student to discuss the characteristics of successful students.

Last year was the first time to teach fulltime and to teach Algebra I students. I was shocked. I had high expectations. I didn’t expect the low pass rate. So this year I knew what to expect and so I called each student and discussed with them what qualities they needed to possess, like self-motivation, in order to pass.

An orientation was provided for both the students and their parents at the beginning of the semester. Mrs. Smith also indicated that she did conduct an orientation with her students and their parents, but insisted that it did not help. She experienced a lot of frustration due her inability to make a connection with the students and their parents.

I give the parents and the students an orientation so the parents know how to check on their child’s assignments and grades, but it doesn’t help. I just sent out progress reports [October 2006] to 23 parents of students receiving a D or an F. I got no response. In the next few days I am going to call every parent.

Mrs. Smith did not spend a lot of time working with her students on time management. At AVHS this is not her responsibility. The school offers an Online Study Skills class for the purpose of teaching the students how to be successful in an online course. Mrs. Smith states that this course was ineffective with her students.
We do offer a study skills class that all freshmen must take, but the outcomes of these classes go right along with the type of response I get in my class. Most fail.

Mrs. Smith was very effective in her student progress monitoring and often attempted to contact both the student and her parents when an issue, whether academic or behavioral, arose. However, this is also a frustrating process for Mrs. Smith, as she says that she has little success in making contact with the parents or receiving a return call from parents in response to her messages.

In terms of her technology skills, Mrs. Smith was well qualified in the use of the technology that was used by the students in the course (i.e., Centra, WebCT, and email). Where there was a disconnection in her technology skills was the infusion of other technologies that might have enhanced or differentiated her instruction. Mrs. Smith said that she had significant control over the design of the course and that she was happy with the way the class was set up. Mrs. Smith took a lot of pride in her course. She put a lot of hard work and thought into her instructional slides for Centra and her materials for WebCT.

I feel I have a significant role in how the class is set up. Personally, I like the way the class is set up and I like the lessons. I think it can be user-friendly if the students are doing what they are supposed to be doing. That to me is the problem. However, the structure and instructional techniques are very traditional and do not follow recommended guidelines for online teaching and course design. This was not just an issue involving Mrs. Smith. Her time was limited and she should not be a design team of one. Based on the previous discussion of ISD, one way to handle this is for the course to be a product of a large team of developers, which would include Mrs. Smith, using an instructional design approach to the development of the course.
Mrs. Smith’s online facilitation techniques and her assignments, activities, and assessments procedures received a low score. As noted above, this may be due to the lack of adequate training and the poor course design, for which she should receive more support from the school or district. However, as stated above, some of her problems also lie in her traditional approach to her instruction of the content. The course was designed to address all of the appropriate content. However, the instruction was weak in terms of the best practices recommended by NCTM, NEA, and SREB. When asked about the differences in how she managed her face-to-face classes as compared to her online classes, she gave this account.

In the face-to-face classroom, I did deal with students who did not participate, but usually I could get them involved one way or another. For instance, I had a stack of index card with each student's name on it, and I would constantly use them to call on students. At the beginning of the year, I always let the kids decorate them, put nicknames on them, etc. So it became a game. I would just randomly pick a card from the deck, and that person would have to answer. So the students never knew when they were going to be called on. If they answered 10 questions correctly, over a 9 week period (I had a tally sheet) then they received a free homework pass for that quarter, so it did give the students a motivation to pay attention.

In my online class, I don't really have a system like that. I never know what the students are doing during class. They could sign in and walk away from their computer and I would never know. They could be on My Space, or playing video games, and I would never know......UNLESS.....I call on them and I get no response. The participation is a lot lower in my online classes because I don't have the ability to monitor them during the lesson. I tell them often that I will assume they are not there if they don't respond, so therefore they will be ejected [removed from the session]... So it's like negative reinforcement versus positive reinforcement for participation (or lack of). Maybe I can make changes, however, it is obvious that I can't use their grades (giving them a free [homework quiz] pass) as a motivation because 90% of the students don't take the [homework quizzes] anyway.

Mrs. Smith was teaching students who were not motivated and her use of negative reinforcement by ejecting students from the class did not improve the situation. It may be
that in a face-to-face situation she can be a motivating teacher, but she was less effective in an online environment with at-risk students.

In Mrs. Smith’s course there was only one path to learning the content, which followed the very traditional path of lecture, computational assignments, weekly quizzes, a mid-term exam, and a final exam. Each week was structure the same as exemplified by the weekly agenda slide in Figure 6.21. Students were assessed on participation and discussion, but the prompts from Mrs. Smith did not energize an effective discussion, either in the Centra sessions or in the WebCT discussion forum.

The following are two exemplars that illustrate the problem with the WebCT discussion forum. The first example discussion, between Mrs. Smith and Karen, was from one of the first weeks, September 5th. In this example, there were 26 exchanges in the week’s forum, but only 14 were student responses. The other 12 were responses by Mrs. Smith in response to each student’s post. Only one student, Susan, actually responded back to Mrs. Smith’s comments to her posts. The other students did not return to the discussion forum. Karen did not respond to Mrs. Smith’s prompt for more information.

**Mrs. Smith’s Post:** In class, we discussed the differences between Natural Numbers, Whole Numbers and Integers. Compare and Contrast these types of numbers. Give an example of each.

**Karen’s Post:** The compare and contrast of Natural Numbers, Whole numbers, and integers is a Natural number is any number that isn’t 0, Whole numbers are different because they include 0, and Integer is any number and its opposite

*Examples*

*Natural Numbers*- 1,2,3,4,5,6,7,8,9
*Whole numbers*- 0,1,2,3,4,5,6,7,8,9
*Integer*- -5 and +5
Mrs. Smith’s Response Post: On the right track...but do you really mean that an integer can be ANY number??

During the week of October 31st there were only 11 postings in WebCT discussion on the topic of the difference between a zero slope and an undefined slope.

Mrs. Smith’s Post: Explain the difference between a line with a zero slope and an undefined slope.

Susan’s Response: A slope with a zero slope is horizontal and a slope that is undefined is going vertical.

Mrs. Smith’s Response to Susan: Good!

Ann’s Response: A zero slope is horizontal and a slope that is undefined is going vertical. (notice that Ann’s response is exactly like Susan’s)

Mrs. Smith’s Response to Ann: That's right, good!

Kim’s Response: A zero slope is a slope that is horizontal line and an undefined slope is a vertical line.

Mrs. Smith’s Response to Kim: That’s right.

Mrs. Smith’s Second Post: So, what would make a line undefined? What does that mean?

Cindy’s Response: The slope and line with zero differ because with the undefined the slope is zero is a horizontal line and the slope that is underfined is a vertical line.

This exchange was not a discussion. Rather it was a question and answer session. It might serve as a way for Mrs. Smith to discover who in the class understands this one fact and who was participating in the WebCT discussion forum, but it did not enhance the instruction or help the students to contextualize the concept. This was the typical discussion format in each week’s WebCT’s discussion forum. The discussion is even less effective when a student copies another student’s answer as Ann did with Susan’s
response. By December 11th there were only two posts; one by Mrs. Smith and Susan’s response.

There were no open-ended discussions or assignments that challenge the students to conceptualize the content for different situations, representations, or solutions. Figure 6.16 is a lecture slide from a Centra lecture session on integers using the Tip-to-Toe method to solve an addition problem using negative and positive integers. Mrs. Smith called on a student to solve the problem $+3 + (-5) = ?$ using this method. The student suggested using the -5 first since it was in parentheses. So he drew a line to -5 on the number line. Then he said to move backwards on the number line by +3, which gave the answer of -2. Negative two was the correct answer for the problem. However, Mrs. Smith said this solution was incorrect because he started with the -5 even though it was in parentheses.

Figure 6.16: Centra lecture slide of a student’s alternative solution to a problem
She said that since there were no operations in the parentheses one should start with the - 3. Rather than recognizing that the student had conceptualized the problem in his own way, she essentially corrected him because he was not following her strict rules for solving this problem.

Mrs. Smith was strong in providing guided practice in the Centra sessions, but as in this example, she was inflexible in her expectations for a “right” solution. After a Centra session was over, the remainder of the week the students had access to the content through the Centra session playbacks, by rereading the WebCT content, or by emailing the teacher for help. There was no use of manipulatives in the course.

*Instructional Design*

The area of instructional and audience analysis was very weak (see Figure 6.17). The course design was not the product of a systematic process and as a result the inclusion of effective instructional strategies and technology enhancements that would lead to the students developing a greater conceptual understanding of the material was simply not present.

Mrs. Smith was the design team. It could have helped Mrs. Smith to be part of a team of designers to develop this course. Part of a systematic design process is to perform an instructional and audience analysis so that the developers are aware of the specific needs of the students who will be taking the course. With such an analysis, the developers can infuse the course with a flexible learning environment that allows for the differentiated instruction and the real-life connections that are considered essential in both online best practices and the NCTM standards.
The course structure was designed and developed to be teacher-centered. The structure of the course was lecture-based with pre-designed computational assignments and weekly quizzes (see Figure 6.18).

### 1.1.4 Subtraction of Integers

To subtract integers, "add the opposite" and use the rules from addition!

\[
5 - 9 = \quad \begin{array}{c}
\framebox{5} \\
\framebox{-9}
\end{array}\quad = \quad 4
\]

\[
(-5) - (-9) = \quad \begin{array}{c}
\framebox{5} \\
\framebox{-9}
\end{array}\quad = \quad \quad (-4)
\]

\[
11 - (-9) = \quad \begin{array}{c}
\framebox{5} \\
\framebox{9}
\end{array}\quad = \quad 20
\]

\[
-8 - 9 = \quad \begin{array}{c}
\framebox{-5} \\
\framebox{+9}
\end{array}\quad = \quad -4
\]
Although the curriculum was challenging, it was not standards-based and it did not support multiple learning styles. Accentuating that problem was the lack of openness that would have encouraged the students to provide input as to how the instruction might be altered to meet their need or engage their motivation to learn. The course was organized into units and lessons within WebCT (see Figure 6.19). However, navigation to all areas of WebCT was not immediately obvious to the students, thus it was not exceptionally user-friendly.

![Figure 6.19: Content page for the entire online Algebra I course.](image)

There are examples of online courses that have successfully used single page presentations for the unit for each week so that students did not have to navigate through a maze of web pages. In those examples, everything the student needs to know is available on just one page that is easily printed as a reference for the week (Talvitie-Siple, 2005). In this course, the student had to first locate the module and then follow the links to the individual web pages associated with the week’s assignments and tests. Several students reported that this navigation was confusing and it may have contributed to failing to complete an assignment.
As part of the design, Mrs. Smith did a very good job of making sure that each week the students understood how to contact her for help (see Figure 6.20). She made herself very available to the students. She made sure the students had their materials (i.e., textbooks) prior to the beginning of the class. Although a previous Algebra I teacher handed down her instructor notes to Mrs. Smith, Mrs. Smith ultimately re-designed the course alone and consequently she created her own instructor notes and gathered her own resources. There were no standardized instructor notes or resources made available to new teachers.

![Figure 6.20: The contact slide for each week, which was altered to protect the real contact information.](image)

The content followed the NCTM content standards for Algebra I with the exception of how the content was taught. The instruction was not NCTM standards-based. The instruction was very traditional. Although each week Mrs. Smith presented a warm-up lesson (see Figure 6.21) that represented a real-life scenario, the primary emphasis of the course was on computational skills. The lack of contextualizing the content led to the lower score in the evaluation. The instructional strategies left me asking the same questions we often hear from students. Why would I need to know this content?
How or where would I use it? What relevance does it have to my life? Why do I have to learn algebra?

The implementation of the course was very good. The description and requirements were available in advance; counselors were available to advise both the students and their parents. All materials were sent out in advance and tutorials were made available so the students could understand how to use the technology required in the course. The evaluation process could be far more effective. Although student evaluations were gathered at the end of the course, these evaluations were not shared with the teacher. Since the teacher was the designer, this feedback was necessary for her to understand so that she could make revisions in light of the student evaluations.

Figure 6.21: Warm-up slide from a Centra lecture session
**Support Systems**

Overall the school’s support system was well structured and helpful (see Figure 6.24). Students were allowed to borrow a computer from the school, but also had the option of using their own computer at home. Student and parent orientations are provided. Students were provided a pre-recorded orientation in Centra prior to starting classes (see Figure 6.22). Technical training was available to the students for learning the technology. Counselors were available and in some of the brick and mortar schools provided course facilitators for the students who took one or two online courses via AVHS but at their home school. The infrastructure and architecture supported the current technology used with few problems, such as downtime.

The school provided in-house professional development that Mrs. Smith indicated addressed the standards, best practices, and developing materials. I was not able to evaluate these sessions directly. Mrs. Smith indicated that professional development sessions were typically presented over Centra and that she received all of her training in-house, including the use of WebCT and Centra.

Figure 6.22 represents an example of an agenda slide from a professional development session within the Centra environment. Outside training directly from the developers of this technology may have or may not have provided a more comprehensive understanding of the technology’s potential. Since I did not attend any professional development sessions, I could not directly assess the quality or content of the sessions. Attendance at conferences is permitted and would be an excellent professional development opportunity where Mrs. Smith could engage in conversations with other teachers, benefit from research presentations, and engage in seminars or training sessions.
on best practices. Mrs. Smith has attended conferences in the past and the district will pay
$22.00 per hour for her to attend conferences. However, no provisions are made for
substitutes so the teacher must pre-record her Centra sessions in advance so that the
students can access the content through the playbacks. Students under those
circumstances are not able to ask questions as the content is being delivered. This is not
an ideal arrangement.

Figure 6.22: Teacher professional development agenda slide

In terms of online resources, the school relies on outside websites that are listed
on one webpage on the school’s website. There is no access to an online library. The
school may have assumed that the students had access to the local public libraries, but
what the school did not recognize is that the students may or may not have access to a car
and that it should not be the responsibility of the student to leave his virtual school to
locate research materials.
The school provided a desktop computer to every fulltime student at AVHS unless the student chose to use his personal computer. There is a deposit of $50.00 for each computer on loan to a student. No printers are provided and head-sets are sold for $20.00. The school or district did not provide an Internet connection. Thirty to thirty-five percent of the students were still using dial-up service to access their courses, which the technology support director indicated was insufficient for AVHS’ online courses. However, none of the 10 students in the study were using dial-up connections.

Summary: Research Question II

To answer this question the e-LETAC (see Table 4.5) tool was used to describe AVHS’s online Algebra I course systematically in light of the existing principles of best practice in mathematics and virtual high school learning environments. The e-LETAC
was developed from a compilation of the best practices and standards of NCTM, Education Alliance, NEA, and SREB to ensure that the tool possessed the essential indicators of teacher quality, instructional design, and support systems.

The scale for the e-LETAC tool was from zero to five. Zero indicated that there was either no information available to form a conclusion or I was not able to observe activities that addressed the specific indicator. A score of one was assigned if an indicator was not met. A score of two was assigned if an indicator was partially met and a score of three was assigned when an indicator was fully met.

Based on the average score assigned to the course (1.92), the course is in need of improvement when compared to existing pedagogical best practices and content standards. Mrs. Smith was highly qualified but did not exhibit NCTM standards-based teaching. The course represented a very traditional approach with little allowance for students to conceptualize or contextualize the content. Although Mrs. Smith included a real-life situation each week in the form of a warm-up, the emphasis of the instruction was on computational skills. Mrs. Smith designed the course by herself. There was little interaction within the Centra sessions and especially in the WebCT discussion forum. The WebCT discussion forum was a question and answer session rather than an actual discussion that could stimulate the students to conceptualize various situations, form different representations, and interpret and apply their solutions to another situation.

There was no instructional design team to develop the course systematically with her. As a fulltime online teacher, Mrs. Smith should be supported by a design team so that her course could reflect the best practices recommended by the virtual high school industry. The design was teacher-centered. Navigation was adequate but needs
improvement. The overall design did not support a standards-based curriculum, thus the content lacked the integration recommended by NCTM. In Figure 6.24, the areas in the bold-border boxes represent the portions of the Algebra I curriculum framework (Kleiman, 1998) that was the focus of AVHS’s online Algebra I course.

The computational content taught is represented by a lighter grey, which was first semester content. There was no expectation that the course would cover the second semester content, although Mrs. Smith did cover scatter plots in the course. What was missing was the triangular integration between the situation, the mathematical representations, and the mathematical findings.

Figure 6.24: AVHS online Algebra I course focused on computational skills
AVHS’s support system was reasonably efficient in providing professional development opportunities, counselors, and orientations and training sessions. The infrastructure supported the high demands of Centra with few downtimes reported by either the teacher or the students. Technology support for issues either the teacher or the students encountered were handled usually within 24 hours of a complaint.

The most important deficit that, if corrected, could improve AVHS’ program is in the area of required technology. Since the students are required to attend the Centra sessions and those sessions are most effective when the student can openly discuss the content in the class, it seems logical that all students should be provided with the headphones free of charge. In addition, the technology team should be available to troubleshoot any student’s technology problems. The practice of supporting only the computers that are loaned by the school leaves open an excuse not to attend classes or complete their work if they claim that their computer is not working properly. Computers often have technical problems that may take a day to repair or two or three weeks to repair, and often at a significant expense. It might be prudent to require that every fulltime student use a school assigned computer and then provide the technology support, so that a student does not fall behind in their studies due to a technology problem or lack of funds to repair a computer.
Table 6.21: Completed e-LETAC for the evaluation of AVHS online Algebra I course

1 = does not meet the indicator  2 = partially meets the indicator, but needs some improvement  3 = meets the indicator, no improvements obvious

<table>
<thead>
<tr>
<th>Teacher Quality Criteria</th>
<th>NEA &amp; SREB Indicators</th>
<th>Algebra I Evaluation Tool (Standards/Pedagogy)</th>
<th>Q#</th>
<th>$</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Preparation</td>
<td>8. Meets state licensing requirements in the field she/he is teaching.</td>
<td></td>
<td>1</td>
<td>3</td>
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<tr>
<td></td>
<td>9. Familiar with state and national standards and curriculum for the subject she/he is teaching.</td>
<td></td>
<td>2</td>
<td>2</td>
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<tr>
<td></td>
<td>10. Has completed professional development training in online teaching strategies and has first hand experience as an online student.</td>
<td></td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11. Attends professional development sessions to improve old or learn new teaching strategies.</td>
<td></td>
<td>4</td>
<td>3</td>
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<tr>
<td></td>
<td>12. Maintains a reflective approach to teaching and is open to changes.</td>
<td></td>
<td>5</td>
<td>3</td>
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<tr>
<td></td>
<td>13. Self-evaluates teaching and course structure, presentation, and documents.</td>
<td></td>
<td>6</td>
<td>3</td>
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<tr>
<td></td>
<td>14. State Licensed 9-12 Mathematics teacher or National Board Certified in Mathematics in Adolescence or Young Adulthood</td>
<td></td>
<td>7</td>
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<table>
<thead>
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<th>Preparation and Organization</th>
<th>NEA &amp; SREB Indicators</th>
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<tr>
<td></td>
<td>11. Teacher prepared course materials are uploaded in advance of the course start date.</td>
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<td>8</td>
<td>3</td>
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<tr>
<td></td>
<td>12. Reviews student records to understand the student’s prior academic experiences &amp; ability levels.</td>
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<td>9</td>
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<td></td>
<td>13. Provides syllabus with goals, objectives, expectations, assignments, and assessments, including due dates and penalties.</td>
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<th>Student Progress Monitoring</th>
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<th>Comments</th>
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<tr>
<td></td>
<td>20. Guides students in time management skills.</td>
<td></td>
<td>11</td>
<td>1</td>
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<tr>
<td></td>
<td>21. Establishes expectations for response times for instructor/student, and student/student electronic communications.</td>
<td></td>
<td>12</td>
<td>3</td>
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<tr>
<td></td>
<td>22. Developed monitoring system for student interaction and academic progress.</td>
<td></td>
<td>13</td>
<td>3</td>
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<tr>
<td></td>
<td>23. Contacts both the student and parents when issues arise.</td>
<td></td>
<td>14</td>
<td>3</td>
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**Teacher Quality Criteria**

**NEA & SREB Indicators**

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<th>Comments</th>
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<tr>
<td>15</td>
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<td>Mrs. Smith does not make full use of technology to enhance the instruction. School has not provided this option.</td>
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**Technology Skills**

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<td>Traditional instruction. Few NCTM recommended practices. No differentiation. Supports some problem-solving. Discussion is a question/answer forum only, which is an unsuccessful attempt at best practices.</td>
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**Technology Policies and Support**

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<th>Comments</th>
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<td>24</td>
<td>1</td>
<td>Traditional instruction. Few NCTM recommended practices. No differentiation. Supports some problem-solving. Discussion is a question/answer forum only, which is an unsuccessful attempt at best practices.</td>
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**Online Facilitation Techniques**

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<tbody>
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<td>67</td>
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<td>Traditional instruction. Few NCTM recommended practices. No differentiation. Supports some problem-solving. Discussion is a question/answer forum only, which is an unsuccessful attempt at best practices.</td>
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</tbody>
</table>
### Teacher Quality Criteria

<table>
<thead>
<tr>
<th>Assignment, Activities, &amp; Assessments</th>
<th>NEA &amp; SREB Indicators</th>
<th>Algebra I Evaluation Tool (Standards/Pedagogy)</th>
<th>Q#</th>
<th>S</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Assignments, Activities, & Assessments | 77. Promotes open and respectful communication with the students and the parents.  
78. Provides multiple paths to success, including alternative and authentic assignments and assessments that are learner-centered and linked to real-world situations.  
79. Provides prompt and timely formative and summative feedback to which students have continuous access.  
80. Scoring rubrics available to students for all assignments and assessments.  
81. Provides opportunities for students to self-assess their performance and progress, and encourages active ownership of the learning process. | 82. Use manipulatives  
\( e \). That are aligned with math concepts  
\( f \). To develop understanding  
\( g \). To demonstrate word problems  
\( h \). Align with the standards  
83. Student self-monitoring  
84. Use both traditional & alternative strategies  
85. Use open-ended techniques  
86. Include diagnostic, formative, & summative strategies  
87. Conduct error analysis of student work  
|                                      | 40 | 1 |  
41 | 2 |  
42 | 1 |  
43 | 1 |  
44 | 1 |  
45 | 1 |  
46 | 2 |  
47 | 1 |  
48 | 2 |  
49 | 1 |  
50 | 3 |  |

### Instructional Design

<table>
<thead>
<tr>
<th>Instructional and Audience Analysis</th>
<th>NEA &amp; SREB Indicators</th>
<th>Algebra I Evaluation Tool (Standards/Pedagogy)</th>
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<th>Comments</th>
</tr>
</thead>
</table>
| Instructional and Audience Analysis | 89. The instructional design follows the ADDIE model or similar.  
90. Analysis includes and validates the course meets the school or district credit requirements.  
91. Instructional strategies, materials, and resources reflect the knowledge, skills, and tasks required for the learner to develop an understanding of the content. | 92. Differentiate instruction  
93. Build on prior experience/knowledge  
94. Include real-life connections  
95. Identify skills/concepts/knowledge to be mastered | 51 | 1 | Poorly designed. No IDS used. Teacher created courses follow school credit requirements. No NCTM pedagogy. No differentiation. Very traditional—not appropriate for OL. |
|                                    | 52 | 2 |  
53 | 2 |  
54 | 1 |  
55 | 1 |  
56 | 2 |  
57 | 2 |  |

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<th>S</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>96. Course structure represents a well constructed learning environment that is user-friendly and learner-centered.</td>
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<td></td>
<td>97. Course is organized into units and lessons.</td>
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<td></td>
<td>98. Contact information and policies are present and clear.</td>
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<td></td>
<td>99. Media selected is appropriate for the learning environment and content, and enhances the learning process.</td>
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<td>58</td>
<td>1</td>
<td>Course structure is teacher-centered. Structure requires improvement in accessibility for Centra and organization in WebCT.</td>
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<td>59</td>
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<td>61</td>
<td>2</td>
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<tr>
<td>Development</td>
<td>72. Instructional materials are created and tested prior to implementation.</td>
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<td></td>
<td>73. Instructor notes and resources are created and built into the design.</td>
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<td></td>
<td>74. Student resources and materials are available and designed to increase student success.</td>
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<td></td>
<td>75. Multimedia enhancements are tested to ensure appropriateness and interoperability with the required technology.</td>
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<td></td>
<td>76. Course supports multiple learning styles.</td>
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<td></td>
<td>77. Use challenging content</td>
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<td></td>
<td>78. Use standards-based curriculum</td>
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<td></td>
<td>79. Ensure curriculum is vertically &amp; horizontally articulated</td>
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<td></td>
<td></td>
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<td>62</td>
<td>1</td>
<td>Instructional material created by teachers and tested in active class only. Instructor notes/resources are created by the teacher and handed down. Nothing formal. Student resources are minimal via WebCT and playbacks of Centra. Multiple learning styles not supported. Not standards-based. Vertical/Horizontal curriculum unknown.</td>
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<td>63</td>
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</tr>
</thead>
<tbody>
<tr>
<td>Development</td>
<td>80. Content, objectives, goals, and assessments are aligned with national, state, and/or district content standards, and the students’ grade and skill level.</td>
<td></td>
<td></td>
<td></td>
<td>Teacher presents appropriate content for course. However, the instruction is based almost solely on computation and vocabulary. Little attention is paid to alternative solutions for different situations. Little attention is paid to extracting and representing various situations as a mathematical representation. No application or interpreting of computations back to various situations.</td>
</tr>
<tr>
<td>Content</td>
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<tr>
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<tr>
<td>Content</td>
<td></td>
<td>h. recognize and generate equivalent forms for simple algebraic expressions and solve linear equations</td>
<td>d</td>
<td>2</td>
<td>Modeling for various situations in not present or very weak in the lessons. Full analysis in terms of various relationships weak.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>74. Use mathematical models to represent &amp; understand quantitative relationships. Model and solve contextualized problems using various representations, such as graphs, tables, and equations.</td>
<td>73</td>
<td>1</td>
<td>Instruction is very traditional and does not incorporate recommended NCTM pedagogy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75. Analyze change in various contexts. Use graphs to analyze the nature of changes in quantities in linear relationships.</td>
<td>74</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Implementation</td>
<td>93. Course description, with objectives and expectations, &amp; technology requirements, is available to all in advance.</td>
<td>75</td>
<td>3</td>
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<tr>
<td></td>
<td>94. Counselors are available to advise students, parents, &amp; teachers, including the enrollment process</td>
<td>76</td>
<td>3</td>
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<tr>
<td></td>
<td>95. Required materials are sent to students in advance.</td>
<td>77</td>
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<td></td>
<td>96. Technology is tested and verified to be working in advance.</td>
<td>78</td>
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<td></td>
<td>97. Introductions, user tutorials, &amp; FAQ’s are available in advance.</td>
<td>79</td>
<td>3</td>
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</tbody>
</table>
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<tr>
<td><strong>Evaluation</strong></td>
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<tr>
<td>98. Student evaluation &amp; assessment data is collected during and after the course, and correlated to course content, delivery, &amp; effectiveness.</td>
<td>103. Evaluate both the student progress &amp; performance, &amp; the teacher effectiveness</td>
<td>80</td>
<td>2</td>
<td>Student evaluations collected at end of course. Correlation process unknown.</td>
</tr>
<tr>
<td>99. Student evaluations &amp; supervisory evaluations are shared with the teacher as a tool that encourages growth and improvement.</td>
<td></td>
<td>81</td>
<td>1</td>
<td>Student evaluations not shared with teacher. Only overall summary is shared.</td>
</tr>
<tr>
<td>100. Evaluation is reviewed from both the student’s and the teacher’s perspective.</td>
<td></td>
<td>82</td>
<td>1</td>
<td>No evidence of revisions to course due to evaluations.</td>
</tr>
<tr>
<td>101. All evaluations are available to the teacher for review.</td>
<td></td>
<td>83</td>
<td>1</td>
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<tr>
<td>102. Revisions are made in light of the evaluation feedback using a systematic design process.</td>
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<td>84</td>
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<tr>
<td><strong>Support Systems</strong></td>
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<tr>
<td>104. Teachers and the course design teams are provided professional development opportunities to improve online teaching strategies, learn new technologies that may enhance learning, and to continue to be aware of new research in the field.</td>
<td>106. Provide professional development e. Understanding/Using standards f. Using best practices g. Developing/providing support materials h. Using multiple assessments</td>
<td>86</td>
<td>3</td>
<td>In-house PD provided. Teacher may attend conferences specific to virtual schools.</td>
</tr>
<tr>
<td>105. Orientation training is provided for third-party course software.</td>
<td>107. Establish mathematics leadership teams</td>
<td>87</td>
<td>2</td>
<td>No district money? Research may be shared but not obvious.</td>
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<td></td>
<td></td>
<td>88</td>
<td>2</td>
<td>Training in-house.</td>
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<td></td>
<td></td>
<td>a</td>
<td>2</td>
<td>No formal mathematics team.</td>
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<tr>
<td></td>
<td></td>
<td>b</td>
<td>2</td>
<td>Informal collaboration occurs.</td>
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<td>c</td>
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<tr>
<td>Student &amp; Parent Orientation</td>
<td>108. A orientation program is provided to introduce the teachers, the students, &amp; the parents to each other.</td>
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<td></td>
<td>109. Promotes an open and respectful communication with the students and the parents.</td>
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<td></td>
<td>110. Program includes technical training of the learning environment and the required computer skills.</td>
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<td>92</td>
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<td></td>
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<tr>
<td>Counselors &amp; Facilitators</td>
<td>96. Counselors are available to answer questions, meet with students and parents, and check in on the student’s progress.</td>
<td>98. Course facilitator has completed professional development such as VHS Site Coordinator Orientation or similar</td>
<td>93</td>
<td>3</td>
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<tr>
<td></td>
<td>97. Course facilitators are available at onsite course locations and/or serve as virtual aides for the teachers.</td>
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<td>94</td>
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<tr>
<td>Resource Availability</td>
<td>100. Teachers and students have online access to the library and other resources needed to enrich the learning process.</td>
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</thead>
</table>
| Technology Infrastructure | 101. The infrastructure and architecture supports interoperability, and has the capacity to support the system with limited to no down-time.  
102. Course navigation is user-friendly and meets universal design principles.  
103. The architecture supports robust multimedia content and permits the teacher to make changes to the content, activities, and assessments as needed to differentiate or extend the learning opportunities. | | 97 | 3 | WebCT navigation has too many places to hide resources. Teacher may change content, but not multimedia to differentiate instruction as needed. |
| Technology Support | 102. The school provides required technology to the students or provides financial assistance so the students may acquire the technology.  
103. Tech support responds within 24 hours. | | 100 | 2 | PCs loaned on request to FT students. Tech support only for loaners. No printers. Headsets are $20. |
| | | | 101 | 3 | |
Section III: Research Question III

What specific pedagogical practices are perceived by secondary students enrolled in a virtual high school Algebra I course in an e-learning environment as contributing to their motivation to learn, mathematics attitudes, and perceptions of transactional distance and social presence?

The third question was answered through two student interviews conducted midterm and at the end of the term. During the final interview, the students were directed to three websites that represented different virtual approaches to provide potential enhancement content instruction. After each approach was demonstrated, the students commented on how useful they thought the website might be to their ability to learn the content of their Algebra I course. In addition, other questions that were asked were specifically designed to draw out pedagogical practices of the course that they thought affected their learning during the semester (see Appendix J). This section is divided into three sub-sections: The Teacher, The Technology, and Advice to Future Students.

The Teacher

It appeared that Mrs. Smith was well liked by all of her students. Every student talked about her sweet or friendly personality and her humor. However, the students did not seem to develop a close relationship with Mrs. Smith. She was generally considered a very nice teacher, but the students felt that she was just like any regular teacher. Kim reported that she has a “cool” relationship with Mrs. Smith, but admits that it is difficult to know online teachers as well as face-to-face teachers.

Sherry: Um from when I met her she was cool and all...Just like a regular teacher...like everyone else in the world. But I mean I never really pay attention so I don’t have any like real thoughts on her. Cause I don’t know her really.
**Kendra:** Well, I don’t really know a lot about her. All I know is that she is really upbeat. She likes to listen to kids. …She’s just a great teacher. I mean I think she will go far with her attitudes because she is very nice.

**Kim:** Um…our relationship is pretty cool, like it’s basically like a regular teacher and student, except I think, yeah, it’s perfectly normal. Like there are certain teachers you really don’t like, but in [AVHS] there are teachers that you don’t like because you don’t know them as well. I think you can’t get to know them as well because you can’t see them and you can’t see how they are all the time.

Mrs. Smith made herself available and her content information was always the second slide in each Centra session, so that students were reminded every week how to contact her for questions or problems. The students all agreed that Mrs. Smith was readily available to them. Susan said that she felt she had a “24/7 way to get in contact with Mrs. Smith.”

**Kendra:** I mean, my mom talked to her one time about me and after that my mom was really surprised because she wasn’t used to that, because the teachers in the [Eastern state] are really mean. She was very kind and while I was having problems she talked to my mom, too, and I was able to go back into class and she got me through some reading stuff.

In terms of Mrs. Smith’s instructional strategies, there appeared to be mixed opinions. Some students felt that she was efficient at using step-by-step instruction and would make sure that all of the students understood a concept before moving to the next content. Others felt that she did not do enough or that she had a different learning style that interfered with her ability to instruct a particular child. I observed, and some students mentioned, that Mrs. Smith remained after class to answer questions from students. She did not place a limit on how much time she spent with each student.

**Kim:** It’s fairly simple to understand what the teacher is saying. If you don’t understand you can stay after class. She will go over it more in class to make sure you understand it.

**Karen:** I was hoping that the teacher would explain more and use step by step instructions. Face-to-face is better because there is less work and the teacher
explains things step by step. [Mrs. Smith] is a cool teacher. She acts like a teenager and that makes her cool. She talks about her life. But she doesn’t explain much.

**Susan**: [Mrs. Smith] is a really nice person. [I]met her face-to-face at the spaghetti feast. Great teacher, doesn’t let you get by with one short answer. You have to tell her what you mean. She takes everything step by step. If you don’t get it she goes back. She is just a helpful teacher.

**Kendra**: …Then I moved up here and then the teacher, I think she is really good, but I just don’t understand because my learning skills are different from hers, so its hard to like try to combine them together.

In terms of what advice the students would give to Mrs. Smith if they could, most students did not seem to have any strong feelings about specific changes that Mrs. Smith could make. Kendra said that Mrs. Smith “does a great job and she knows what needs to be done”, but Kendra suggested that the mood of the course could be changed to make the overall atmosphere more relaxed and sociable. She suggested that Mrs. Smith should balance the work and the fun. Cindy agreed that she felt that Mrs. Smith was “a mentor and [she] respect[ed] her as a leader”, but she would like to have more fun in class. Cindy suggested that Mrs. Smith’s slides could be more interesting and that introducing some videos might be helpful. Susan was concerned about the amount of interaction and suggested that Mrs. Smith try to increase the interaction in the class. However, Kim suggested that the discussion requirement should be optional, but if discussion was required then some of the discussion time should be devoted to allowing the students to talk about what’s going in their lives so they could “get to know each other better.”

When asked if meeting face-to-face every four weeks would affect their learning, all but Mike, Maria, and Sally said they would like that to occur, but all of the students agreed that if they were going to meet face-to-face they would like the purposes of the meetings to be both a social event and a study session.
The ejection process was of concern to Mike and Kendra. When Mrs. Smith called on a student in Centra and the student did not respond, the student risked being ejected from the course. Mrs. Smith would attempt to call on the student over the course of about 2 minutes, after which she would assume that the student was signed on to Centra but not actually participating in class. She indicated that she tried to give ample time for a student who might be using a dial-up connection to respond. None of the 10 students in the study used a dial-up connection that might have hampered participation in the course. There was no way for Mrs. Smith to know if there was a legitimate reason the student was not responding, so she took disciplinary action. The process of ejecting simply forced the student out of Centra for the remainder of the session. The student was able to watch the playback of the session to catch up on the content, but the student was considered absent from class. Both Mike and Kendra indicated that they had not been ejected from a Centra session and both indicated that they would be very sad or disappointed if it had happened to them.

**Mike**: I would feel bad because if I was doing something I need to do and then if I didn’t get back in time I would be ejected and I wouldn’t be able to learn. So it would upset my learning and I’d feel sad.

**Kendra**: I would feel disappointed because some people get ejected for little things they did not mean to do. Like if they got to go to the bathroom and forgot to step out [a special icon indicates if someone has stepped out and then returned]. Or if they are doing something too long they’d get ejected. I would feel bad sometimes.

When asked how they might deal with a similar situation as the teacher, they both indicated they would attempt to talk to the student after class and wait to see if the student participated better in the next session.

**Mike**: I would see if they were there and if they weren’t then I would wait a couple of minutes and see if they were there. And then you’d probably have to
talk to them and if they did it again you should probably eject them and say “you should have been there.” [An excuse] I would accept is like if they were going to the bathroom or needed to help somebody in the house for a second.

**Kendra**: I’d probably wait until the end of the class and talk to him and find out what was the problem and tell him not to do it again. And if he did it again, I’d probably eject him. I would be nice, but I would be bold with it because I want them to know that, yeah, you can get away with it a little but don’t try, don’t trying to get away with it because it's not going to work out.

The inability for a teacher to see their students in an e-learning environment creates a particularly difficult situation in terms of discipline or reacting to a student’s body language as a face-to-face teacher would. Both Mike and Kendra seemed to understand that there had to be a line where the teacher had to make a decision about a student’s participation in class and respond through the ejection process, so long as the teacher had made an attempt to verify if there was a reasonable explanation as to why the student did not respond to her prompts.

Options were presented to the student that would affect the teacher’s instruction and the course design. Generally, only 50% of the students were not interested in having more than one Centra session per week and even less were interested in projects that allowed them to get out of the house to perform real-world projects from the information they had obtained. Most would strongly consider going to their regular school to take the quizzes or a test.

**The Technology**

The technology background of each student provided a lens through which one could view why a particular student might have certain opinions on the technology used in the class. Mrs. Smith knew this and asked each student at the beginning of the course
to provide in their profiles their background in technology. Of the 10 students in the study, six responded to Mrs. Smith’s prompt.

Mrs. Smith: What is your tech background? Are you an experienced computer user or are you just starting out? What types of programs are you familiar with? Word processing, draw or paint programs, databases, spreadsheets, creating web pages?

Susan: I am pretty good with computers. My parents call me a computer junkie because I am constantly doing something new. I can send emails, use Word processing, draw and paint, use spreadsheets, and I am excellent on creating web pages.

Ann: I work well with computers though I can’t fix most problems on them. I have been using a computer for about 8 years now. I love to use Microsoft Works, which has word processing, databases, and spreadsheets. I sometimes use drawing and paint programs but not usually.

Karen: I am experienced at computers…..Sometimes. I am familiar with all those programs and have used them tons of times.

Cindy: I live on the computer. All with Microsoft and many with Mac.

Kim: My dad taught me how to use the comp when I was in elementary school and over the years my comp skills have developed nicely. I am familiar with word processing, paint programs and myspace.

Sally: I’m pretty experienced with the computer but I’m not nerdy. I don’t always know how to fix my tech problems. I’m familiar with the programs Microsoft word, Word Processing, and drawing.

Table 6.19 raises the question of the nature of the WebCT hits and if the numbers represent technical issues that prevented some students to log into WebCT. Overall, the total number of hits was not a function of technical issues experienced by the students. In general, the students had few complaints about the technology used in the course. Given that the students were well versed in technology, this was not surprising. When asked what affected their satisfaction with the course, a few had some definitive comments.

Kendra: The playback. Yeah, I really think that was really good. I think that was the smartest idea that they did, the virtual playback. Like in regular school you
can’t do a playback unless you have a camcorder and tape your whole day. But it’s much easier if you are slower at learning if you can see, you can really go back and check everything. It’s cool because you can go back and check everything from the beginning, so it is really cool.

**Mike:** Centra is easy to use. But in WebCT things are hard to find. I would make WebCT simpler. It would be easier if everything was organized into one long page. Interact [the email client] is ok, too….The playbacks also helped a lot.

**Cindy:** I would allow students to not do the discussion in WebCT. I would keep the quizzes in WebCT. But I would be doing a lot better if all of the course was in Centra. Like you get more personal interaction. I’d stay focused.

Since the students seemed to like the opportunity to watch the Centra playbacks I asked them how they felt about the practice of closing the sessions associated with a completed quarter so that they would no longer have access to that quarter’s playback sessions.

Both Mike and Kendra had comments about this practice.

**Kendra:** I feel sad because I know I have a duty to do and I’m screwing up and I should’ve done it the first place before going into playback and everything.

**Mike:** Well, if it is actually the first part you are kinda late but you didn’t realize it and you talk to the teacher about it you should be able to make it up and get, like probably not full credit, but you know something.

This discussion led to the question asking if students should have a longer time to complete the course. Kendra thought that would be helpful. Alex agreed that it would help but it would affect when a student graduated.

During the interview I showed students three websites that pertained to Algebra I topics. These websites are referenced in Appendix J with the second interview questions. The first website was an online math tutorial. I showed the students a demo lesson about integers and asked them if they thought the site would affect their learning. All of the students, except Kim, agreed that interactive tutorials, such as the example, would be
helpful. The students agreed that using an interactive review for exams would also be very helpful.

The second site was about the Fibonacci ratio. The website discussed the ratio and tied the concept into the proportions of individual’s faces that were considered beautiful by society standards. The site used Tom Cruise and Jessica Simpson as examples. The student could manipulate the ratio and see how a perfect or near perfect ratio provided a near exact outline of each of the star’s faces. Other faces that were not considered as attractive by societal standards were also available to examine how those faces were not congruent with the ratio. The purpose of showing this site to the students was to hear their reactions to using real-life examples to explain difficult concepts. Some students liked the site and others did not, but Kendra had the most interesting reaction to this site.

**Kendra:** It looks fun. First of all it would attract people because they are famous stars and that is what people really like and so I would think it would be good because their showing math through their faces, which I didn’t realize you could do and it is really cool that you can fix [manipulate] the picture like that.

During interviews with Kendra, it appeared that she was a kinesthetic learner and she would respond positively to anything that she could manipulate to understand a concept.

The third website was a video on algebraic vocabulary from the Annenberg Media site. This video infused real-life examples to introduce algebraic vocabulary. The downloading of the site was difficult and consequently the students did not see much of the video, so I described the concept to them. No one had a strong reaction, but most agreed that placing such videos on the WebCT site might be helpful for some students.

Each student was asked to respond yes or no to which technologies that are not currently being used in the course they thought would positively affect their learning. The technologies that received the most positive reactions included:
- Short online videos on how to solve a problem of the week,
- Interactive tutorials and exam reviews, and
- Automatically generated emails reminding them of their deadlines.

The students were given an opportunity to consider what they would do if money was not an issue and they were given an opportunity to create the best online Algebra I course (see Table 6.22).

Table 6.22: What would you do to create the best online Algebra I course?

<table>
<thead>
<tr>
<th></th>
<th>Think about it... If you had all the money in the world and the opportunity to create the best online Algebra I course, what would you do? Be creative!!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ann</td>
<td>I would make it so that everyone would get the material on the first try and make the learning fun but doing all the material in a type a game way. I would probably also make it so that everyone would love the course so much that they would want to come back time and time again, by only letting them have fun while learning to do math at the same time.</td>
</tr>
<tr>
<td>Cindy</td>
<td>I’d first have to design a holographic. I think that could possibly be the best way to learn. Then I would make it so that while being a difficult course it could be fun and have some crazy projects.</td>
</tr>
<tr>
<td>Karen</td>
<td>Make it for people to understand, step by step guides, be online checking emails as much as possible, have techs online to help kids during class, and one-on-one help.</td>
</tr>
<tr>
<td>Kendra</td>
<td>Well, what I would is put all the work that we have to for the semester in different folder. The first day of school I would put on a show for them. Let them get comfortable and get to know each other. Not do any work but play math games. The next day I would start from there with the work and have fun. If anybody is to quit I would asked them to stay after class and get them do the work because that’s one thing about me is I am very persuasive.</td>
</tr>
<tr>
<td>Kim</td>
<td>Wow, this is hard! If I had all the money in the world to create an online Algebra one class I would hire scientists to create holograms of the teacher and have them teach the students the lessons. That would be so cool. And I would invent a devise that the students could write on that displays their work on the computer because what we use now is really hard to write with. I would make sure that each student had one-on-one time with the teacher, which would be possible with the holograms. I would have an area that students can call in their questions and would be answered immediately. Only the best for my online students!</td>
</tr>
</tbody>
</table>
Think about it.... If you had all the money in the world and the opportunity to create the best online Algebra I course, what would you do? Be creative!!

<table>
<thead>
<tr>
<th>Name</th>
<th>Idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maria</td>
<td>I don't know. I guess I might like it if it was more interesting.</td>
</tr>
<tr>
<td>Mike</td>
<td>I would make all the homework in one place, and have it done in class.</td>
</tr>
<tr>
<td>Sally</td>
<td>I'm not sure.</td>
</tr>
<tr>
<td>Sherry</td>
<td>I would get the best technology and the best more interactive teachers ever. I also make sure it was better and more interesting for the students so that they would pay attention in the class.</td>
</tr>
<tr>
<td>Susan</td>
<td>I would provide all of the students with up to date laptops to take the courses. I would hire the best Algebra teacher to teach. I would also arrange tutor sessions for those who are struggling.</td>
</tr>
</tbody>
</table>

It seems that all of the students would increase the fun and interest in the course.

This concept is related to the ARCS model, where it is recommended that the course design be such as to grab the *attention* of the students. Two students, Kendra and Mike, wanted to have all of the course materials in one spot so that students could find everything easily. The organization of the course affects the student-to-interface interaction, which can either increase or decrease the transactional distance students’ perceive in a course. Kendra, along with 8 other students, was in favor of receiving emails reminding the students when assignments are due. Susan reinforced the concept of improving the student-to-interface interaction with her suggestion that every student should have an updated laptop. Providing such laptops would reduce the digital divide between the students, especially if the school covered the expense of providing a broadband Internet access. Those students without printers, which the school does not supply, are also at a disadvantage since they must do everything online. Constant viewing of a computer monitor is hard on the eyes and does not allow for a hard copy to be printed so that the student has some flexibility in where to work.
These 10 students in the study are the Star Trek Generation’s children or grandchildren. They are the next generation and have incorporated in their world the concepts of Star Trek’s 24th century, with the use of interactive holographic images to teach and tutor students. This fanciful concept suggests that the students really want to have one-on-one attention and that they feel the need to have more access to the teacher or other study support. Susan reinforced the need to have tutors available for those students who are struggling. It is interesting that the students are calling out for more individualized instruction to be available, when AVHS does offer after school and weekend tutoring sessions, as well as study skills classes for each subject area. Perhaps AVHS’ availability is not well known or is at an inconvenient time, or perhaps the students just do not want to attend. The advantage of a hologram is that the student could access such technology at any time without traveling outside their room.

The image of an “education to go” concept comes to mind, where the students needs may be instantly provided for any time. As Kim said, “I would make sure that each student had one-on-one time with the teacher, which would be possible with the holograms. I would have an area that students can call in their questions and would be answered immediately.” The concept of a holographic teacher suggests that the students are not as concerned about social presence among the students in a course, as they are about teacher presence. The hologram concept also suggests that the students are looking for a way to peak students’ interest, which would help with not only accessing the students’ attention, but also increasing the relevance of the course. A holographic classroom could be programmed to make instant changes when needed to motivate a student or soothe a student’s math anxiety. It seems clear that the students feel that the
course needs more interaction that is not always related to mathematics and they are interested in anyway or technology that can improve the learning in their online learning experience.

Advice to Future Students

Given varied experiences of the students in this course, students were asked what advice they would give to students who are considering entering the virtual school world of AVHS. Each student’s response is shown in Table 6.23. Whether the student had failed the course or passed with a good grade, the responses were similar. The students agreed that attending classes and completing the work was paramount. Kendra, Sally, and Susan recommended getting help to understand the content. Cindy, Maria, and Sherry said that if a student cannot follow through with classes and the work, the student should not attend AVHS. Cindy and Sherry agreed that staying motivated was essential to attending AVHS. Perhaps the most insightful comment came from Kendra, who encouraged the students to be sure their “mom” was involved and understood what was required so she could be of help with deadlines and other issues that might crop up.

Table 6.23: Advice from the study’s students to potential AVHS students

<table>
<thead>
<tr>
<th></th>
<th>What advice would you give to a student considering attending AVHS?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ann</td>
<td>I think I would tell them to: be self-motivated, get the work done, and don’t miss class.</td>
</tr>
<tr>
<td>Cindy</td>
<td>You need to know what you are doing, pay attention, be prepared, and learn the tech stuff quickly and efficiently. Have the will to do it—stay motivated. You need to put the time and effort into it. If you can’t [then] stay in a brick-and-mortar school. If you do have the time, [then] just stick with it.</td>
</tr>
<tr>
<td>Karen</td>
<td>I would tell students that there is a lot of homework. Do your best.</td>
</tr>
<tr>
<td>Source</td>
<td>Advice</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Kendra</td>
<td>I would say go for it, because you don’t ever try then it won’t even matter. But I think if they just go for it, they will like it a lot. And there are opportunities to express themselves or change something. I think it’s great if somebody wants to go here. It’s very fun and upbeat and if you have problems you can talk to somebody about things. Sometimes you might get bored if you just sitting here all the time, but that’s where your friends come in. I would say make sure mom is here and have her understand what you are going through so if you forget something least your mom would remember or if she forgets something you’d remember. So with both participating you would see where the problem is or not. I would say use the playback all the time.</td>
</tr>
<tr>
<td>Kim</td>
<td>I would say show for every class, don’t miss any classes, pay attention in class, and do your assignments.</td>
</tr>
<tr>
<td>Maria</td>
<td>Don’t go to [AVHS] if you get distracted, because you have to pay attention and do the work.</td>
</tr>
<tr>
<td>Mike</td>
<td>They need to be Ok at the PC. I would tell them that it is not as easy as it seems. Do the home work.</td>
</tr>
<tr>
<td>Sally</td>
<td>I would say to the students that they should attend the classes and really do the work and quizzes. Get help if you need to.</td>
</tr>
<tr>
<td>Sherry</td>
<td>I would tell them that they need to be determined to do the program and it will be a piece of cake. But if they can’t handle it they need to think of other options.</td>
</tr>
<tr>
<td>Susan</td>
<td>I think I would say to stay focused and if you ever need help don’t be afraid to ask.</td>
</tr>
</tbody>
</table>

**Summary: Research Question III**

The students appeared to be very pleased with Mrs. Smith’s personality and upbeat approach to her instruction. The students seemed to really like her. The few suggestions they had were consistent with Mrs. Smith’s weaknesses that were exposed in the analysis of Question II (see Table 6.21). Interaction and differentiated instruction is very important in online learning and the students would like to see an improvement in that area. Mrs. Smith was weak in this area of her instruction. The students were interested in various ways to increase student-to-student interaction. Most suggested that the WebCT discussion forum could be improved. The students suggested that the student-
to-student interaction could be increased with the addition of a class meeting that combined academics and socializing, such as face-to-face meetings to get to know each other and to receive extra help. The Student Council for AVHS organizes social events, such as a Spaghetti dinner. Mrs. Smith advises a student organization in cooperation with the local humane society and animal shelter.

The students appeared to be very computer capable, but the ability to troubleshoot and solve technology problems should not be an expectation of the students. As one student said, “I don’t always know how to fix my tech problems.” Susan suggested that all students be given an up-to-date laptop, rather than a desktop. This suggestion would give the students more freedom to study from locations outside of the home and the assurance that all students are on an equal footing in terms of the computer technology. Some students found the navigation within WebCT confusing and suggested that everything for one week be located on one webpage. This would free students from constantly browsing the course WebCT site for everything they needed to know. Many students mentioned during the two interviews that the Centra playback option was very helpful.

Those students who passed the course generally had less to say about the technology or the teacher. However, the students who were failing were a little more vocal, although hesitant when discussing Mrs. Smith. The students who were not succeeding in the class wanted more fun infused into the class. These students also responded favorably to the potential of enhancing technology that could be infused into the curriculum.
When asked what advice they would share with a student who was considering attending AVHS, the students gave advice that they should be listening to, as well. The students know why they are failing a course and they also know that any student who chooses AVHS must be a self-motivated, self-directed student.
CHAPTER VII
SUMMARY AND IMPLICATIONS

Introduction

The purpose of this study was to investigate high school student’s motivation to learn, mathematics attitudes, and perceptions of transactional distance and social presence in an e-learning Algebra I course offered in an urban virtual high school. The study included an evaluation of the course design and pedagogy in light of current e-learning and mathematics best practices, and the students’ perceptions of the pedagogical practices and course design that they felt affected their success in the course.

The study presented here was designed to examine 41 online students of various backgrounds and gender. Ultimately, the study specifically involved 10 virtual high school students, nine of whom were considered academically at-risk. The study examined students’ motivation to learn, mathematics attitudes, and their perceptions of transactional distance and social presence when taught Algebra I in e-learning environment that utilizes both asynchronous (not real-time) and scheduled synchronous (real-time) instruction. The goal of the study was to investigate secondary students’ experiences in an e-learning Algebra I course and how those experiences related to their specific learner profiles and achievement.

The study was conducted at an urban virtual school located in the Western United States. Ten students, who were taking an online Algebra I course, and their teacher participated in the study. Using a triangulation mixed-methods approach, both
quantitative and qualitative data pertaining to the students’ experiences in the online Algebra I course were collected. The quantitative data included the results of four surveys that were used to evaluate the students’ attitudes and perceptions of the course. Other quantitative data included WebCT statistical data on each student’s participation in the course, Centra attendance records, academic records, and demographic information. Qualitative data were collected from interviews, discussion transcripts, open-ended questions on surveys, and asynchronous online classroom observation. This research design allowed the collection and analysis of quantitative and qualitative data simultaneously and then the merging of the results to understand each research question. Through the interpretation of the data, it was possible to consider if the different data sets supported or contradicted each other. This process permitted identification of inconsistencies in the participants’ experiences and any questions that still remained unanswered.

Summary of the Research Questions

Question 1

*Are the motivations to learn, mathematics attitudes, and perceptions of transactional distance and social presence of secondary students enrolled in a virtual high school Algebra I course in an e-learning environment related to their respective learner profiles and mathematics achievement?*

Motivation and mathematics attitudes have played significant roles in the academic success of children. The classroom climate influences how a student develops her attitude towards mathematics. Sociological factors in the classroom, such as competition and peer pressure, affect a student’s level of self-efficacy and confidence towards mathematics (Tobias, 1993). Aspects of motivation, such as relevance and confidence, contribute to a student’s level of math anxiety. Students who lack confidence
and do not find the relevance of taking mathematics experience higher levels of math anxiety (Hilton, 1980a, 1980b). Research has demonstrated that poor mathematics attitudes and poor motivation, especially in relation to confidence, negatively affects mathematics achievement (Ho et.al., 2000; Wigfield, 1994). Often anxiety is exacerbated by a sense of isolation or a sense of helplessness. The student feels there is no one to go to for help or that no one understands him. In an e-learning environment, feelings of anxiety, isolation, helplessness, and poor motivation, are not uncommon. The perceived distance and social presence in an online course may increase or decrease these feelings depending on the course design and pedagogy. With the rise of virtual high schools, researchers must begin to focus attention on what influences the virtual high school student’s experience. This study examined only one subject, online Algebra I.

To answer Question I, students’ learner profiles were developed using their demographic information and scores from the You and Mathematics Survey (see Appendix B), which included four questions on motivation that were part of the Course Interest Survey (see Appendix D). Surveys were administered at the end of the semester to determine each student’s perception of transactional distance and social presence in the course, as well as if there were any changes in the student’s level of motivation or mathematics attitudes. Interviews supplemented the survey data to shed more light on the nuances of the case study.

Learner Profiles

The study had nine girls and one boy that ranged in age from 14 to 16 years old. One girl was Latino, and two girls were African-American. Six students were repeating
the 9th grade. Five students were repeating Algebra I, which includes one student who was taking Algebra I for the third time. Three students received either a D or an F in their prior mathematics course. With the exception of one student, the students in this study were students who were at-risk of failing or at the very least performing poorly. Only one student was the “star” of the class. She passed 8th grade and was promoted to 9th grade with no issues trailing her. She had no issues during the study.

Relationship to the Theoretical Framework

The students who passed the course appeared to be similar relative to their motivation to learn, mathematics attitudes, and their perceptions of transactional distance and social presence. The data suggest that there was a potential relationship between the students’ mathematics attitudes and their final grades. The students that failed the course, with the exception one student, appeared to have poorer attitudes towards mathematics. One might speculate that mathematics attitudes affect the academic performance of not just the traditional student, but also the online student.

Those students who passed the course appeared to possess high motivation. These students’ motivation appeared to be most influenced by their perception of the relevance of the course and their confidence in the course. Confidence also influences mathematics attitudes, so it does not seem surprising that there might be a link between motivation and achievement, as well. Students who failed the course seemed to find the course less relevant and they appeared to experience less confidence, which may have lowered their motivation overall. The passing students also appeared to perceive low transactional distance in the course, which lead to the speculation that a relationship between
transactional distance and motivation may exist. However, transactional distance did not appear to have a strong relationship with mathematics attitudes. Only half of the students seemed to have transactional distance scores that appeared to be associated with their mathematics attitudes. In evaluating the four different interactions that affect the perception of transactional distance, the potential for a relationship between any of these interactions and mathematics attitudes did not seem to exist. Just as in a large lecture hall of 400 students, the online student may experience a great sense of distance between all herself and all the other individuals in the room. If the student has a good attitude towards mathematics, most likely he will perform academically well, but may not leave the course satisfied with the experience. As satisfaction is another component of the ARCS model of motivation, it would not be surprising that those students who appeared to perceive a greater sense of transactional distance might also have less motivation, but that perception might not affect how the student felt about the subject matter itself. This study speculates that this relationship between transactional distance and motivation appeared to exist, but that it was unlikely that a strong relationship existed between transactional distance and mathematics attitudes. The students with lower motivation seemed to perceive greater transactional distance in the course and did not pass the course.

The relationship of social presence and its influence on student achievement or motivation was weak for subjects in this study. However, there appeared to be a potentially strong relationship between the students’ transactional distance and social presence scores, which leads one to speculate that there may be a stronger relationship between motivation, achievement and social presence, but this fact may have been
obscured by the low participant numbers. The level of student participation may have influenced the affect of social presence on student motivation and achievement. The perception of a high level of social presence is contingent on the instructional strategies, the course design, and the participation of the students. However, the opportunities in the class to participate in a flexible environment were not well provided to the students. Perhaps if the course design and instruction had been better suited for interaction, the social presence factor may have been more apparent. There did appear to be a strong relationship between the students’ perception of social presence and their mathematics attitudes. The quality of social presence in a classroom probably affects a student’s attitude towards mathematics. This is in keeping with the concept that sociological factors of the classroom affect math anxiety (Tobias, 1993).

Question II

_How might the design, including the pedagogical practices, of a secondary virtual e-learning Algebra I course be described in light of existing principles of best practices in mathematics and a virtual learning high school environment?_

The creation of virtual high schools is growing every year. The growth is in response to the potential for virtual schools to provide alternative educational opportunities to students who do not have access to highly qualified teachers in their home school or district, who have not been successful in brick-and-mortar schools, who are ill and unable to attend school, or who may be working or have other obligations that interfere with attending their home school. In addition, NCLB has placed significant pressure on the nation’s districts to provide equitable educational access and quality instruction to all students. The National Education Technology Plan (U.S. Department of
Education, 2004) recommends that states, districts, and schools consider the inclusion of e-learning as one potential strategy to meet the requirements of NCLB.

However, the dropout rate of some virtual high school students can be high. If providing e-learning options at the secondary level is specifically designed to accommodate students’ needs for alternative educational opportunities, then it would be helpful to understand why some virtual high schools are plagued with such high dropout rates and others are not. Perhaps the answer to this question lies in the course design and pedagogy offered in our nation’s virtual high schools. To address this question, our virtual schools must conduct rigorous evaluations of their course designs and their pedagogy to ensure that virtual school students are receiving the quality instruction and access to highly qualified teachers that the schools claim to be offering. In addition, a virtual school cannot claim that it is providing an education to its students that is equal to or better than what is offered at the local brick-and-mortar school if they have not performed an evaluation that supports that claim. If that claim cannot be met, then the virtual school cannot provide the quality and equitable service it was created to provide.

To answer this question, an evaluation tool was developed using industry standards for e-learning course design and pedagogy, in conjunction with the standards and pedagogy recommended by the Education Alliance (2006) and NCTM (2000) for Algebra I. Both the e-learning and mathematics standards must be met before a virtual school can claim that its mathematics offerings are equal to the local brick-and-mortar school. The tool included 101 indicators gathered from these standards. The indicators were divided between three main criteria: (1) teacher quality, (2) instructional design, and (3) support systems. Each indicator was weighted evenly. The scoring consisted of a
zero, one, two, or three. Zero was assigned if an indicator could not be observed or documentation was not available. A score of one was assigned if an indicator was not met. A score of two was assigned if an indicator was partially met. A score of three was assigned if an indicator was fully met. With this scoring system the course had the potential to earn 303 points, which would be considered a perfect score. Once the evaluation tool, the *e-Learning Evaluation Tool for Algebra I Courses*, was developed it was used to evaluate the online Algebra I course that was the site of this study. Comments were provided where an indicator was not fully met.

Overall, the AVHS online Algebra I course scored 191.83 points out of 303 possible points, which represents “grade” of 63% out of 100%. When converted to the zero-to-three scale the average score was 1.92. Both teacher quality and instructional design earned 1.88, and the support systems earned 2.13. This data indicated that under every criterion, the course needed improvement.

Mrs. Smith was a highly qualified teacher with eight years of experience teaching algebra and two years of teaching online fulltime. Her training for teaching online was provided by the school’s in-house technical staff, rather than from one of the comprehensive certification programs currently offered across the nation. The lack of experience and more extensive training was visible in her online teaching skills that followed a traditional and somewhat inflexible approach that does not adhere to either e-learning standards or national standards for mathematics teaching practices. Her inability to stimulate and facilitate constructive discussions among the students, or between the student and herself, resulted in almost entirely lecture-based instruction. Such an approach is not aligned with standards-based teaching. Technologies that might have
enhanced the instruction and allowed for differentiation of the instruction were not infused into the curriculum. Despite these shortcomings, Mrs. Smith made every attempt to be an open and accessible teacher, willing to help any student at nearly any time. Overall, all but three students perceived student-teacher interaction as mostly favorable, with the students who passed reporting very favorable student-teacher interactions. All of her students liked her very much, and her students openly admitted that they should have worked harder and that their failures were often due to the fact they had not completed the work.

The instructional design of the course also needed improvement. The course was primarily designed by Mrs. Smith, rather than a design team working together to develop the course systematically to meet the needs of its audience. The course structure was teacher-centered and focused on computational skills. Navigation in WebCT was a complaint amongst the students. I observed that the navigation was confusing and that it was not always apparent where to go for what piece of information. Such issues may affect the level of transactional distance an online student may perceive. The course design should pay close attention to aspects of the design that will affect the student-interface interaction. What appears simple to follow by the developers can easily be confusing to the users. Centra was considered the better tool by the students due to the synchronous interaction and the playback feature. Overall, the use of Centra increased the students’ perception of social presence in the course. In terms of implementation, the course was very good. Orientations and training sessions were provided to every student. Students had the opportunity before classes began for the semester to learn the technology, meet their teacher and counselor, and understand the policies of the school.
The support systems fared better than the other two criteria. Professional
development was provided to the teachers to improve their online teaching skills,
although the research suggests that the more professional development the teacher
receives the better the teacher’s online instruction. Counselors were available to the
students and in some schools facilitators were provided for students who were taking an
online course part-time from their home school. However, the facilitators were not
trained in online learning environments. Each full-time student received a desktop
computer to borrow for the year, but no printers or headsets were provided. Even though
headsets were required, the sets had to be purchased for $20.00. Printers were considered
unnecessary, but students who were successful in the course insisted that printers were
extremely helpful and any student without a printer was at a disadvantage. Students were
not provided with broadband Internet connections, which left up to 35% of the students
still using dial-up, which the school openly admitted was not adequate to participate fully
in the classes. Computer technical support was provided to students who had loaned a
school desktop. Any student using a home computer was not supported by the technical
support team. For example, one student in particular experienced technical problems
using Centra that were not resolved during my observation of the course over the
semester.

In answer to the question, AVHS’ online Algebra I course did not meet the
standards for quality e-learning courses. The lack of a course design team using an
instructional systems design was at least one reason for the lack of quality as it was
apparent that the course was not developed with the audience in mind and had not been
adjusted as needed to accommodate the at-risk students attending the course. Instruction
was not standards-based and did not meet the standards for quality mathematics
instruction or e-learning instruction. Technology was not equally provided to all students.

The effect of this poor course design and instructional practices was that these
virtual high school students did not receive the quality education that they should have
received. Many teachers in the regular schools do not teach standards-based mathematics,
so Mrs. Smith is not very different from many high school mathematics teachers.
However, online students do not have the same benefits of the face-to-face instruction
that can compensate for weaknesses in course design and instruction. They are not always
able to see the body language of the teacher and their classmates, receive immediate
feedback, and have a single location where they can find their work and interact. Online
students are at a disadvantage without a systematically designed course and a highly
trained teacher in standards-based instruction and online teaching. Thus, it may be even
more important that the learning environment be held to the strictest of standards to
assure virtual students that they are indeed receiving equitable education compared to
their peers in the regular schools. Just as in regular schools, where classroom instruction
is expected to be differentiated to meet the needs of every student in the classroom, the
instruction in an online classroom should likewise be differentiated. The only way to
ensure that students are fully benefiting from their virtual school experience is to
recognize where there are issues and work diligently to resolve those issues. Such an
evaluative process should be undertaken in advance of offering virtual high school
courses to our students.
Question III

What specific pedagogical practices are perceived by secondary students enrolled in a virtual high school Algebra I course in an e-learning environment as contributing to their motivation to learn, mathematics attitudes, and perceptions of transactional distance and social presence?

Students should be allowed an opinion about how they receive instruction. Although students may not always understand why instruction is conducted as it is, they are the receivers of the instruction and, as such, have rights within a democratic classroom. Thus, a full evaluation of a course should involve the students. Students’ perceptions add another dimension to the evaluation that provides yet another lens through which to look.

To answer this question, the students were interviewed twice. During these interviews students responded to questions that specifically asked for their opinions on what they perceived as influencing their learning in the class, as well as what aspects of the course they would change or keep the same. Students were also prompted to provide feedback to the teacher and to future students who may consider attending AVHS.

In general, the students found Mrs. Smith a very pleasant teacher. Few students had anything negative to say about Mrs. Smith. Where there was a negative statement, it was more in terms of the student’s perception of differences in personality or learning style, for which the student did not find fault with Mrs. Smith.

Although the students liked Mrs. Smith, generally they did not describe their relationship as any different from that of any other teacher. It was not evident that they had a sense that they knew Mrs. Smith well or that she knew them well. However, this lack of social presence did not seem to be a major issue with the students.
presence became more important was with interactions with their classmates. Students suggested the classroom should be more relaxed and fun and a more sociable learning environment. The teacher-centered lecture environment did not foster such a classroom.

Part of providing a motivating experience is to gain the attention of the students, which requires taking some risks in instructional techniques. Students suggested that there should be more interaction and that the interaction should not only be restricted to academics. Not only would this increase the social presence in the classroom, but it would also reduce the perception of transactional distance. As this study suggests, for these 10 students, a reduction in transactional distance may have increased the students’ motivation, which in turn may have improved the students’ academic achievement. However, at least one student felt that the discussion requirement was not helpful and she wanted the option not to participate. All of the students indicated that a face-to-face meeting every four weeks or so would be very helpful in learning more about their peers and also receiving extra tutoring from Mrs. Smith. These requests for more interaction might suggest that the students are interested in ways to improve their motivation through simply “getting to know each other.” Although, not as evident in the quantitative data, the qualitative data suggests that social presence was important to the students.

In terms of the technology used in the course, the students felt they were competent to participate with little trouble so long as they did not have to troubleshoot problems. One student suggested that all students should be provided the same technology, which would allow the technical support team to troubleshoot for every student, rather than reserving that service only for those students who borrowed a school computer. Centra and its playback feature were well received. The only complaint
associated with Centra was with issues associated with the lack of a working microphone and the possibility of some technical issues that one student did not pursue. Rather, this student received permission not to attend the Centra sessions at all. Students were in favor of receiving automated emails to remind them of their assignments. Students also found WebCT confusing and difficult to navigate at times. Such difficulties with the technologies may have increased the transactional distance the students perceive, which in turn may have affected their motivation to stick with a course.

Students were exposed during the last interview to some technology that might enhance the instruction. These technologies included interactive tutorials, online videos, and interactive websites specific to a mathematical concept. Generally, all the students were in favor of such enhancements that would allow for more differentiation of the instruction and supplemental practice. So long as such enhancements were pedagogically appropriate and technologically supported, the presence of supplemental materials could improve the student-course interaction. Any improvement that differentiates the instruction so that the content is more accessible to every student might have the potential to “snowball” into improving the students’ motivation and perhaps increase the students’ confidence to the extent of improving their mathematics attitudes. For the 10 students in this study, one might speculate that in some of the potential relationships revealed, an improvement in the perception of one construct might have improve the perception of another construct, and so forth.

One of the most interesting responses was to a prompt asking the students to use their imagination to develop the best online Algebra I course they could. They were given complete freedom from extraordinary expenses or available technology. The concept of
holographic images came to mind for some students, where the teacher could be accessed at anytime, and the instruction could be adapted for any student. What was interesting was that the students did not mention building a holographic classroom. They specifically wanted a holographic teacher. This suggests that, although social presence seemed important to them, that at least for some, teacher presence may have been the most important aspect. Most of the students in this class were academically at-risk and each of the students had issues with mathematics and school in general. The ability to “adjust the television set” seemed to appeal to their need for individualized attention.

**Limitations to the Study**

Due to the nature of this study, there were limitations that affected the ability to form solid conclusions or deductive generalities that could be applied to the entire virtual high school industry. The study was not intended to generalize and no causal effect was intended to be implied from the results. Rather, the study was intended to tell the story of one online classroom in an urban virtual high school. Algebra I was chosen because this course is often required by school districts, and as such it was expected that the students enrolled would represent a broader spectrum of students’ abilities, interests, and backgrounds.

Random assignment of students was not possible for this study. This is a common problem in educational research. Students at AVHS were assigned to their classes. At times students were assigned to a video course instead of an online course without being consulted because the video option was the only means by which the student could fit the course into her schedule. I had no control over student placement.
Although the class enrollment was initially 41, there was a very high dropout rate, which resulted in the final enrollment at 15 students. Of those 15 students, only 10 completed the study. This can be a common problem with virtual high school research. In order to avoid low subject numbers, it may be necessary in the future to study multiple classrooms, in multiple school sites. However, to do so would require controls for the differences in curriculum, teacher personality, and instructional strategies, school policies, and many other potential variables.

It was expected that the students in the study would represent a broader spectrum of ethnic diversity, differing levels of experience, and differing academic preparation in mathematics. However, most of the students were taking the course for a second or third time to recover credit. At least eight, and probably nine, of the students who enrolled in the course were already academically at-risk. Consequently there was little diversity in academic ability. Eight of the students were Caucasian, so there was little ethnic diversity. As a result, this research became an in-depth story of only 10 students enrolled in an online Algebra I course and cannot be generalized to another population.

Algebra I was a required course for graduation at AVHS and completion of the course assignments satisfactorily may have motivating effects that were outside of the factors in the study and as such may have affected the outcome of the research. The study addressed this limitation by specifically questioning, both in the initial mathematics survey and in the interviews, what the purpose was for the student to take the course and what goals the student envisioned would be accomplished by completing Algebra I. Future research might address this limitation by comparing online Algebra I students who are required to take Algebra I to students who are not required to take the course.
The instructional style of the teacher may have influenced the outcome of the research. No attempt was made to resolve this limitation. However, observations of her interactions with the students helped shed light on the teacher’s instructional style. The course evaluation included the teacher’s preparation and pedagogical approach. Future research might address this limitation by using more than one teacher in the study, but the research design would then have to consider the additional variables brought to the study through the use of multiple teachers.

The issue of technology can be problematic in any distance education. Specific problems with the technology were noted but no attempt was made to link any one technology issue with the results of the study. However, it is reasonable to wonder if any of the technology issues may have influence the results more than speculated in the study.

Survey studies rely on the honesty of the participant. It was assumed that all answers reflected the honest opinion of the participant, but there was no control for this assumption. The interviews and document examination helped to evaluate the consistency of the survey data. The surveys were slightly modified and were administered online. It is possible that the changes in the surveys and the administration may have changed how the students responded. This limitation was not considered in the scope of this study.

The evaluation tool did not include a comprehensive rubric and did not have inter-rater reliability tests performed before its use. This tool was the first iteration of the instrument, and as such will require a different research study to determine what should be in a comprehensive rubric. The same holds true for attaining inter-rater reliability after the first rubric is formed. Several iterations will be required and tested. The results of the
testing will guide making adjustments before the final evaluation tool can be considered valid and reliable.

Implications

Much of the research on virtual high schools has been conducted using rural school districts and/or AP students, with a focus on implementation and academic comparisons to face-to-face instruction. As evidenced in Chapter II, the research is often biased towards the concept of no significant difference. Few studies have addressed the student experience and the theoretical research that could inform course developers as to how to develop the most effective online courses that serve all of the students who choose to enroll.

There are many stakeholders involved when envisioning what a virtual high school should “look like” and who it should serve. Although not all, many of the nation’s virtual high schools were developed as a perceived quick fix to an old problem; lack of qualified teachers and limited access of our students to courses not offered within the home school or district. Virtual schools are encouraged by the U.S. Department of Education as a potential “fix” to the demands of NCLB. However, a quick fix is not always a quality fix, and in the case of this study, it was clear that there is a need for greater consideration of the development of the infrastructure, the curriculum, the design, and the training of all personnel before a state or district breaks ground for the next virtual school.

The growth of cyber education ‘sends up a cautionary note’, says Elizabeth R. Pape, the president and chief executive officer of the Maynard, Mass.-based Virtual High School Global Consortium. ‘What’s to maintain the quality? We’re at that stage where we need to start to have nationally accepted standards around online-course design and teacher skills to maintain that quality, and we must
require online providers to show the public how they’re meeting those standards’ (Davis, 2006 ¶ 4).

Although this study cannot be generalized, it does provide a lens into the problems faced by the students and their perceptions of what is happening in the virtual classroom. When stakeholders begin to consider revamping a virtual school program, or start to consider the development of a new virtual school, the words and experiences of these students may shed greater light on where there is a need for improvement. The theory behind this study suggests that there are complex relationships between how an online course is developed and how the students perceive the course, which ultimately may affect the students’ academic performance. It is important for the policymakers, the administration, the course developers, and the teachers to remember that all good instruction comes from a strong theoretical foundation and that in an online environment that foundation may be even more important to develop online courses that in actuality will result in no significant difference.

**Future Research**

This study represents a study of a very complex research question. Figure 7.1 graphically portrays the theoretical framework and analysis that was originally considered in this study. To understand the relationships fully between the theoretical constructs investigated in this study to student achievement and motivation, a much larger sample must be used so that more complex statistical analyses may be performed that might allow for more generalization. Understanding more fully how these concepts affect the student’s experiences in a virtual high school will facilitate designing more effective online courses for all students, including those at-risk.
Rice, 2006, used the Delphi Method to develop a list of the issues with the highest priorities for experienced K-12 distance education stakeholders and reported that the top two priorities were: (1) evaluation of course design and delivery and (2) best practices. Researchers should move away from questioning whether e-learning is as effective as traditional instruction and begin to evaluate fully the characteristics of what makes an effective virtual school program. To accomplish this task, virtual school researchers must pull together to develop effective evaluation tools that will provide both the quantitative and qualitative data required to identify these characteristics. The e-LETAC must to be further developed so that it possesses a strong and comprehensive rubric that removes as much subjectivity as possible and at the same time provides as much information to the school, the district, the state, and their course developers and teachers associated with the virtual school. As with Rice’s study the Delphi Method could be used the start the process along with intermediate research studies to develop trustworthy inter-rater reliability.

Figure 7.1: Theoretical framework of the potential relationships between mathematics attitudes, motivation, transactional distance, and social presence in an online mathematics course
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APPENDIX A

ORIGINAL MATHEMATICS ATTITUDE SURVEY

Fennema-Sherman Mathematics Attitudes Scales

(Bold words indicated where I considered potential language changes.)

Instructions:

On the following pages is a series of statements. There are not correct answers for these statements. They have been set up in a way which permits you to indicate the extent to which you agree or disagree with the ideas expressed. Suppose the state is:

Example 1: I like mathematics.

As you read the statement, you will know whether you agree or disagree.

- If you strongly agree, choose A.
- If you agree but with reservations, that is you do not fully agree, choose B
- If you disagree with the idea, indicate the extent to which you disagree by choosing D for disagree.
- If you neither agree nor disagree, that is you are not certain, choose C for undecided.
- Also, if you cannot answer a question at all, then choose C.

Do not spend much time on any statement, but be sure to answer every statement.

There are no “right” or “wrong” answers. The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help you make a choice.

Confidence

1. Generally I have felt secure about attempting mathematics.
2. I am sure I could do advanced work in mathematics.
3. I am sure that I can learn mathematics.
4. I think I could handle more difficult mathematics.
5. I can get good grades in mathematics.
6. I have a lot of self-confidence when it comes to math.
7. I am no good in math.
8. I don’t think I could do advanced mathematics.
9. I am not the type to do well in math.
10. For some reason, even though I study, math seems unusually hard for me.
11. Most subjects I can handle O.K., but I have a knack for **flubbing** up math.
12. Math has been my worst subject.

**Anxiety**
1. Math doesn’t scare me at all.
2. It wouldn’t bother me at all to take more math courses.
3. I haven’t usually worried about being able to solve math problems.
4. I almost never have gotten **shook up** during a math test.
5. I usually have been at **ease** during math tests.
6. I usually have been at **ease** in math classes.
7. Mathematics usually makes me feel uncomfortable and nervous.
8. Mathematics usually makes me feel uncomfortable, restless, irritable, and impatient.
9. I get a **sinking feeling** when I think of trying hard math problems.
10. My mind goes blank and I am unable to think clearly when working mathematics.
11. A math test would scare me.
12. Mathematics makes me feel uneasy and confused.

**Effectance Motivation**
1. I like math puzzles.
2. Mathematics is enjoyable and stimulating to me.
3. When a math problem arises that I can’t immediately solve, I stick with it until I have the solution.
4. Once I start trying to work on a math puzzle, I find it hard to stop.
5. When a question is let unanswered in math class, I continue to think about it afterward.
6. I am challenged by math problems I can’t understand immediately.
7. Figuring out mathematical problems does not appeal to me.
8. The challenge of math problems does not appeal to me.
9. Math puzzles are boring.
10. I don’t understand how some people can spend so much time on math and see to enjoy it.
11. I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.
12. I do as little work in math as possible.
APPENDIX B

YOU AND MATHEMATICS SURVEY & MATHEMATICS EXIT SURVEY

This survey was administered at the beginning of the semester to provide a baseline of the students’ attitudes towards mathematics. This survey also included some extra questions to gather demographic data, some information on the students’ comfort levels with technology, their reasons for taking Algebra I, and their reasons for taking an online course. This survey was administered at the end of the semester, without the extra questions, to provide comparison data for the purpose of determining if there was any change in the students’ attitudes towards mathematics. All modifications were with the approval of Dr. E. Fennema (personal communications, 2006).

This first section of the survey was only present in the first administration, the “You and Mathematics Survey.”

Completing this section will help me to understand a little about you. When answering these questions, pick the answer that best describes you.

1. What is your name? (This is asked strictly for identification purposes.)
2. What is your correct address? (I need this to send to you your paycheck.)
3. What is the BEST email I can contact you at?
4. Choose the race/ethnic group that best describes you.
   a. Caucasian
   b. Black, African-American
   c. Black, Carribean
   d. Asian, Pacific Islander
   e. Hispanic/Latino
   f. Native American/Eskimo
   g. Other
5. What is your gender?
   a. Male
   b. Female
6. What is your age?
   a. 12
   b. 13
   c. 14
   d. 15
   e. 16
   f. 17
   g. 18
   h. 19
7. What grade are you in?
   a. 9th
8. How comfortable are you taking an online course?
   a. Very comfortable
   b. Somewhat comfortable
   c. Neutral (not comfortable or uncomfortable)
   d. Somewhat Uncomfortable
   e. Very Uncomfortable

9. How comfortable are you using computer technology?
   a. Very comfortable
   b. Somewhat comfortable
   c. Neutral (not comfortable or uncomfortable)
   d. Somewhat Uncomfortable
   e. Very Uncomfortable

10. What technologies used in this course are you finding difficult to use? (freeform)
11. What technologies used in this course do you find to be easy to use? (freeform)

12. Choose the statement at best describes your reason for taking an Algebra I course.
   a. I am taking the course only because it is required.
   b. Although it is required, I would take it anyway because I like mathematics.
   c. The course is a prerequisite for the harder mathematics courses I want to take.
   d. I have to make up this course.

13. Are there any other reasons you are taking Algebra I that was not already mentioned? (freeform)

14. Choose the statement that best describes why you are taking a virtual high school course.
   a. I am not able to attend a traditional school because I am disabled or ill.
   b. I am not able to attend a traditional school because I work during the day.
   c. I just think it is easier.
   d. I don’t like attending a traditional school for any of my courses.
   e. I don’t want to attend a traditional school for this course.
   f. I have to make up this course and it seemed the best way to do it.
   g. Taking this course online seemed like a flexible way to attend class.
   h. I feel better about myself in an online math course.

15. Are there any other reasons that you are taking a virtual high school course that was not already mentioned? (freeform)
This section is the body of both surveys: You and Mathematics and Mathematics Exit Survey.

**Instructions:**

1. In this section of the survey there are 40 statements. The purpose of this section is to learn how you feel about mathematics.
2. There are NO right or wrong answers to these statements. They have been set up in a way that allows you to tell us how much you agree or disagree with the ideas in each statement.
3. Choose the answer that best describes how you fell now, not what you would like to feel or what you think others want to hear.

**Key**

- Strongly Agree
- Agree
- Neutral (don’t agree or disagree or not sure)
- Disagree
- Strongly Disagree

Suppose the state is:

Example 1: I like mathematics.

As you read the statement, you will know whether you agree or disagree.

- If you really agree, you would choose “Strongly Agree.”
- If you mostly agree but not completely, then you would choose “Agree.”
- If you don’t agree or disagree (or you are not sure), then you would choose “Neutral.”
- If you mostly disagree with the statement, you would choose “Disagree.”
- If you really disagree, you would choose “Strongly Disagree.”

Do not spend much time on any statement, but be sure to answer every statement.

There are no “right” or “wrong” answers. The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help you make a choice.

1. Generally I have felt secure about attempting mathematics.
2. I am sure I could do advanced work in mathematics.
3. I am sure that I can learn mathematics.
4. I think I could handle more difficult mathematics.
5. I can get good grades in mathematics.
6. I have a lot of self-confidence when it comes to math.
7. I am no good in math.
8. I don’t think I could do advanced mathematics.
9. I am not the type to do well in math.
10. For some reason, even though I study, math seems unusually hard for me.
11. Most subjects I can handle O.K., but I have the ability to mess up math.
12. Math has been my worst subject.
13. Math doesn’t scare me at all.
14. It wouldn’t bother me at all to take more math courses.
15. I haven’t usually worried about being able to solve math problems.
16. I almost never have gotten upset during a math test.
17. I usually have been at relaxed during math tests.
18. I usually have been at relaxed in math classes.
19. Mathematics usually makes me feel uncomfortable and nervous.
20. Mathematics usually makes me feel uncomfortable, restless, irritable, and impatient.
21. I get a nervous feeling when I think of trying hard math problems.
22. My mind goes blank and I am unable to think clearly when working mathematics.
23. A math test would scare me.
24. Mathematics makes me feel uneasy and confused.
25. I like math puzzles.
26. Mathematics is enjoyable and stimulating to me.
27. When a math problem arises that I can’t immediately solve, I stick with it until I have the solution.
28. Once I start trying to work on a math puzzle, I find it hard to stop.
29. When a question is let unanswered in math class, I continue to think about it afterward.
30. I am challenged by math problems I can’t understand immediately.
31. Figuring out mathematical problems does not appeal to me.
32. The challenge of math problems does not appeal to me.
33. Math puzzles are boring.
34. I don’t understand how some people can spend so much time on math and see to enjoy it.
35. I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.

Questions 36-40 were taken directly from the Course Interest Survey and added to the first administration of the mathematics survey: You and Mathematics. These questions were designed to provide a simple baseline on the students’ motivation.

36. I do as little work in math as possible.
37. I feel confident that I will do well in Algebra I.
38. Whether or not I succeed in Algebra I is up to me.
39. To accomplish my goals, it is important that I do well in this class.
40. I do NOT think I will benefit much from this class.
APPENDIX C

ORIGINAL COURSE INTEREST SURVEY

Due to permission and copyright limitations, the entire Course Interest Survey (Keller, 2006) is not included. Sample questions only are included. To gain access to the original survey in its entirety, contact Dr. John Keller directly.

Instructions:

1. There are 34 statements in this questionnaire. Please think about each statement in relation to the instructional materials you have studied, and indicate how TRUE it is. Give the answer that truly applies to you, and not what you would like to be true, or what you think others want to hear.
2. Think about each statement by itself and indicate how true it is. Do not be influenced by your answers to the other statements.
3. Record your responses on the answer sheet that is provided, and follow any additional instructions that may be provided in regard to the answer sheet that is being used with this survey. Thank you!

Key

1 (or A) = Not True
2 (or B) = Slightly True
3 (or C) = Moderately True
4 (or D) = Mostly True
5 (or E) = Very True

1. The instructor knows how to make us feel enthusiastic about the subject matter of the course.
2. The things I am learning in this course will be useful to me.
3. I feel confident that I will do well in this course.
4. This class has very little in it that captures my attention.
5. The instructor makes the subject matter of this course seem important.
11. The subject matter of this course is just too difficult for me.
12. I feel that this course gives me a lot of satisfaction.
24. The instructor uses an interesting variety of teaching techniques.
25. I do NOT think I will benefit much from this course.
26. I often daydream while in this class.
31. I feel rather disappointed with this course.
APPENDIX D

MODIFIED COURSE INTEREST SURVEY

Due to permission and copyright limitations, the entire Modified Course Interest Survey (adapted from Keller, 2006) is not included. Sample questions only are included. To gain access to the original survey in its entirety, contact Dr. John Keller directly.

Instructions:
1. There are 34 statements in this survey. There are NO right or wrong answers for these statements. Please think about each statement in relation to the class you have studied, and indicate how TRUE it is.
2. Give the answer that truly describes how you feel, and not what you would like to be true, or what you think others want to hear.

Key

1 = Not True
2 = Slightly True
3 = Moderately True
4 = Mostly True
5 = Very True

Suppose the statement is:

Example 1: I like mathematics.

- If you feel this is NOT true for you, then you would choose “Not True.”
- If you feel this is slightly true for you, then you would choose “Slightly True.”
- If you feel this is moderately true for you, then you would choose “Moderately True.”
- If you feel this is mostly true for you, then you would choose “Mostly True.”
- If you feel this is very true for you, then you would choose “Very True.”

Do not spend much time on any statement, but be sure to answer every statement.

There are no “right” or “wrong” answers. The only correct responses are those that are true for you.

Think about each statement by itself and indicate how true it is. Do not be influenced by your answers to the other statements.

1. The teacher knows how to make us feel enthusiastic about Algebra I.
2. The things I am learning in this course will be useful to me.
3. I feel confident that I will do well in Algebra I.
4. This class has very little in it that captures my attention.
5. The teacher makes Algebra I seem important.
11. The subject matter of this class is just too difficult for me.
12. I feel that this class gives me a lot of satisfaction.
24. The instructor uses an interesting variety of teaching techniques.
25. I do NOT think I will benefit much from this course.
26. I often daydream while in this class.
31. I feel rather disappointed with this course.
APPENDIX E

ORIGINAL SCALE OF TRANSACTIONAL DISTANCE

(Bold indicates items I either considered removing or did remove from the survey to reduce the length.)

Instructions:

The purpose of this survey is to learn about your perceptions and experiences in this course. There are no right or wrong answers. Answer the questions as truly as they reflect on your perceptions and experiences. Read the statements carefully, but do not spend a lot of time on each statement.

Please read the following statements and rate your response on a scale of 1 to 5.

1 = Strongly Disagree
2 = Disagree
3 = Neutral (don’t agree or disagree or not sure)
4 = Agree
5 = Strongly Agree

Perceptions of the Web Environment
1. It is difficult to pay attention to the instructor in the web environment.
2. I have adequate access to the resources I need.
3. The fact that I’m online does not inhibit my class participation.
4. An efficient system is provided for students and teachers to exchange materials.
5. I am comfortable using the computer.
6. I hate using the web.
7. It was easy for me to use the technology involved in this online course.
8. The technology used in this online course was very difficult to learn and use.

Perceptions of the Course Content
9. The content of this course was of great interest to me.
10. I don’t know why I have to learn the materials.
11. The exams in the course have challenged me to do my best work.

In this program, my coursework emphasized the following mental activities:
12. Synthesizing and organizing ideas, information, or experiences into new, more complex interpretations and relationships.
13. Making judgments about the value of information, arguments, or methods such as examining how others gathered and interpreted data and assessing the soundness of their conclusions.
14. Applying theories of concepts to practical problems or in new situations.
Perceptions of the Teacher
15. The teacher generally answered the students’ questions.
16. The teacher paid no attention to me.
17. I received prompt feedback from the teacher on my academic performance.
18. The teacher was helpful to me.
19. The teacher was available to answer my questions.
20. The teacher could be turned to when I needed help in the course.

Perceptions of the Other Students
21. I learned a lot from observing the interactions among the students.
22. The students in this course challenged me to do my best work.
23. I got along very well with my classmates.
24. I felt valued by my class members in this course.
25. My classmates in this course regard my ideas and opinions very highly.
26. My classmates respected me in this course.
27. I was good at working with the other students in the course.
28. I felt a sense of kindred spirit with my fellow classmates.
29. The class members could be turned to when I needed help in the course.
30. There were students I could turn to in this course.
31. The class members were supportive of my ability to make my own decisions.

Perceptions of the Class
32. I was thoroughly engaged in learning in this program.
33. I enjoyed learning in this program.
34. I often expressed myself in class.
35. I was encouraged to express my opinions.
36. I felt part of a learning community in this course.
37. Overall interaction was low in this course.
38. Interaction between the teacher and the students was high.

Perceptions of the Outside Environment
39. The environment outside of this class (for example, your home environment, work, and neighborhood) was helpful with my learning in this class.

Perceptions of Learning
40. I learned a great deal in this course.
41. I made tremendous progress in my mathematics goals.

Student Satisfaction
42. Overall, I was satisfied with this course.
APPENDIX F

MODIFIED SCALE OF TRANSACTIONAL DISTANCE

The key for this survey was reversed to be consistent with the other surveys the students were taking.

Instructions:

1. In this survey there are 31 statements. The purpose of this survey is to learn about your feelings and experiences in this course.
2. There are NO right or wrong answers for these statements. They have been set up in a way that allows you to tell me how you agree or disagree with the ideas in each statement.
3. Choose the answer that best describes how you feel now, not what you would like to feel or what you think others what to hear.

Key

1 = Strongly Agree
2 = Agree
3 = Neutral (don’t agree or disagree or not sure)
4 = Disagree
5 = Strongly Disagree

Suppose the state is:

Example 1: I like mathematics.

As you read the statement, you will know whether you agree or disagree.

- If you really agree, you would choose “Strongly Agree.”
- If you mostly agree but not completely, then you would choose “Agree.”
- If you don’t agree or disagree (or you are not sure), then you would choose “Neutral.”
- If you mostly disagree with the statement, you would choose “Disagree.”
- If you really disagree, you would choose “Strongly Disagree.”

Do not spend much time on any statement, but be sure to answer every statement.

There are no “right” or “wrong” answers. The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help you make a choice.
1. It was difficult to pay attention to the teacher in the web environment.
2. I had adequate access to the resources I need.
3. The fact that I was online did not change how I participated in class.
4. Giving and receiving materials with other students and my teacher was easy and fast.
5. I hated using WebCT.
6. I hated using Centra.
7. It was easy for me to use the technology involved in this online course.
8. The technology used in this online course was very difficult to learn and use.
9. The teacher generally answered the students’ questions.
10. The teacher paid no attention to me.
11. I received quick feedback from the teacher on how I was doing in the class.
12. The teacher was helpful to me.
13. The teacher was available to answer my questions.
14. The teacher could be turned to when I needed help in the course.
15. I learned a lot from observing the interactions among the students in this class.
16. The students in this course challenged me to do my best work.
17. I got along very well with my classmates in this class.
18. I felt valued by my class members in this class.
19. My classmates in this course regarded my ideas and opinions very highly.
20. My classmates respected me in this class.
21. I was good at working with the other students in the class.
22. I felt that my fellow classmates felt and thought the way I do.
23. My classmates could be turned to when I needed help in the class.
24. There were students I could turn to in this class.
25. The class members were supportive of my ability to make my own decisions.
26. I was thoroughly engaged in learning in this class.
27. I enjoyed learning in this class.
28. I often expressed myself in class.
29. I was encouraged to express my opinions in this class.
30. I felt part of a learning community in this class.
31. Overall interaction was low in this class.
32. Interaction between the teacher and the students was high.
APPENDIX G

ORIGINAL SOCIAL PRESENCE SURVEY

(Bold words indicated necessary language changes.)

Instructions:

The purpose of this survey is to learn about your perceptions and experiences in this course. There are no right or wrong answers. Answer the questions as truly as they reflect on your perceptions and experiences. Read the statements carefully, but do not spend a lot of time on each statement.

Please read the following statements and rate your response on a scale of 1 to 5.

1 = Strongly Disagree
2 = Disagree
3 = Uncertain
4 = Agree
5 = Strongly Agree

1. Messages on GlobalEd were impersonal.
2. CMC is an excellent medium for social interaction.
3. I felt comfortable conversing through this text-based medium.
4. I felt comfortable introducing myself on GlobalEd.
5. The introductions enabled me to form a sense of online community.
6. I felt comfortable participating in GlobalEd discussions.
7. The moderators created a feeling of an online community.
8. The moderators facilitated discussions in the GlobalEd conference.
9. Discussions using the medium of CMC tend to be more impersonal than face-to-face discussions.
10. CMC discussions are more impersonal than audio teleconference discussions.
11. CMC discussions are more impersonal than video teleconference discussions.
12. I felt comfortable interacting with other participants in the conference.
13. I felt that my point of view was acknowledged by other participants in GlobalEd.
14. I was able to form distinct individual impressions of some GlobalEd participants even though we communicated only via a text-based medium.
APPENDIX H

MODIFIED SOCIAL PRESENCE SURVEY

The key for this survey was reversed to be consistent with the other surveys the students were taking.

Instructions:

4. In this survey there are 26 statements. The purpose of this survey is to learn about your perceptions and experiences in this course.
5. There are NO right or wrong answers for these statements.
6. Answer the questions as truly as they reflect on your experiences, not what you think others what to hear.

Read each statement carefully, but do not spend a lot of time on each statement.

Key

1 = Strongly Agree
2 = Agree
3 = Neutral (don’t agree or disagree or not sure)
4 = Disagree
5 = Strongly Disagree

Suppose the state is:

Example 1: I like mathematics.

As you read the statement, you will know whether you agree or disagree.

- If you really agree, you would choose “Strongly Agree.”
- If you mostly agree but not completely, then you would choose “Agree.”
- If you don’t agree or disagree (or you are not sure), then you would choose “Neutral.”
- If you mostly disagree with the statement, you would choose “Disagree.”
- If you really disagree, you would choose “Strongly Disagree.”

Do not spend much time on any statement, but be sure to answer every statement.

There are no “right” or “wrong” answers. The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help you make a choice.
1. Messages on WebCT were impersonal.
2. WebCT is an excellent place for social interaction (“talking and sharing on a social level”).
3. I felt comfortable conversing (“talking”) through WebCT.
4. I felt comfortable introducing myself on WebCT.
5. The introductions in WebCT allowed me to form a sense of *online community* (a group sharing ideas and feelings).
6. I felt comfortable participating in WebCT discussions.
7. The teacher created a feeling of an *online community* (a group sharing ideas and feelings).
8. The teacher did things that helped us to participate in the WebCT discussion boards.
9. Discussions using WebCT tended to be more impersonal than face-to-face discussions (as in a regular classroom instead of an online classroom).
10. The WebCT discussions are more impersonal than Centra discussions.
11. I felt comfortable interacting (“talking”) with other students in WebCT.
12. I felt that my point of view was acknowledged by other students in WebCT.
13. I was able to form distinct individual impressions of some WebCT students even when we communicated only through the discussion board.
14. Messages on Centra were impersonal.
15. Centra is an excellent place for social interaction (“talking and sharing on a social level”).
16. I felt comfortable conversing (“talking”) through Centra.
17. I felt comfortable introducing myself on Centra.
18. The introductions in Centra allowed me to form a sense of *online community* (a group sharing ideas and feelings).
19. I felt comfortable participating in Centra discussions.
20. The teacher created a feeling of an *online community* (a group sharing ideas and feelings).
21. The teacher did things that helped us to participate in the Centra discussion boards.
22. Discussions using Centra tended to be more impersonal than face-to-face discussions (as in a regular classroom instead of an online classroom).
23. The Centra discussions are more impersonal than WebCT discussions.
24. I felt comfortable interacting (“talking”) with other students in Centra.
25. I felt that my point of view was acknowledged by other students in Centra.
26. I was able to form distinct individual impressions of some Centra students even when we communicated only through the discussion board.
APPENDIX I

INTERVIEW I QUESTIONS

These questions were used to qualitatively assess the personal opinions of the student in terms of the four constructs: motivation to learn, mathematics attitudes, and transactional distance and social presence. The questions were written with the intention of retaining the overtones of each of the surveys.

I opened the interview with a brief discussion of how I lived in the same city when I was growing up and went to high school there. I told them my first teaching job was at a local high school there, but I moved away after I was married. I told them how excited I was to be conducting research in my old stomping grounds.

1. Tell me a little about yourself. Hobbies, interests, goals…
2. What words would you use to describe your experiences with mathematics?
3. Was this the first time you took Algebra I? If not, tell me about your other experiences in Algebra I.
4. Why did you take this course? Did you like this online version?
5. Tell me about this course.
6. What are/were your expectations from this course? What goals did or do you have that are related to this course?
7. How well do/did you expect to do in this course? Do you think you would do the same in other online courses? What about face-to-face?
8. Tell me about the other students in the course? What was your relationship with them?
9. Tell me about your teacher?
10. What was your relationship with her?
11. What things in the course affected to your level of satisfaction?

12. What things in the course affected to your achievement?

13. What things about the course would you change? What might you keep the same?

14. Do you have any suggestions for other students that may take the course in the future? What about the teacher?

Is there anything else you would like to say about the course or your experiences with the course?
APPENDIX J

INTERVIEW II QUESTIONS

The interview questions addressed pedagogical components that the students think might be useful to the course if they were included in the design. The interviews were conducted in Centra or over the telephone. I started with a short explanation of what this interview session was going to be about. I discussed with each student that this was his/her opportunity to think about what they might change or keep the same. I encouraged them to think creatively.

1. Think about it. If you had all the money in the world and the opportunity to create the best online Algebra I course, what would you do?

Now that you have thought about the design of the course, I want to discuss with you some design options. I am curious what you think about these options in terms of your ability to learn about Algebra I.

2. What do you think about including short online videos that show how to solve a problem of the week? How do you think that might affect your learning in the course? Why?

3. What do you think about the course including interactive tutorials? An interactive tutorial would let you try to solve a problem and the computer would tell you if your answer was right or wrong. It might have options that show you how the problem was solved. How do you think that might affect your learning in the course? Why?

4. What do you think about having shorter class time in Centra, but attending more than one session during the week? (Classes were 1 hr 15 minutes. What about 45 minute classes?) How do you think that might affect your learning in the course?
5. During the semester you took each week’s homework quiz on your own time, as long as it was done by the deadline. What do you think about taking the homework quiz at the end of a Centra class session, while you are still online?

6. Would you like to take your courses online, but take then in a computer lab at your home high school instead of at home? Why or why not?

7. What do you think about being assigned homework problems asked you to get out of the house to find a solution? For example, you were asked to go to the grocery store with your parents and while you were in the story you had a problem that you would have to solve by using algebra while you were shopping.

8. Let’s think about WebCT for a minute. Would you make any changes to WebCT?

9. What about the discussions in WebCT? Would you make any changes to the discussions?

10. WebCT has a calendar where your assignments were listed. What do you think about having an automatically generated email sent to you to remind you of your deadlines?

11. What do you think about requiring everyone in the class to meet face-to-face a few times during the semester?

12. If the course did have some required meetings, what would you want these meetings to be about?

I have been wondering about some things.

1. How do you learn? What is your personal learning style? (for example, I learn best if I can put my hands on things. Reading is not as helpful to me.)

2. What aspect of the course do you think helps you the most?
3. What aspect of the course do you think helps you the least?

4. How does any of these things in the course relate to your own personal learning style?

5. How many of you have been ejected from the course?

6. How does that impact you? What do you think or feel about that?

7. Why do you think Ms. O’Gara does that?

8. Do you think there is another way to handle the situation?

9. On another subject, portions of the course close after a term. What do you think about that policy? Would you change it?

I want to show you some examples of online explanations and tutorials:

Algebra Video—Common Terms
http://www.learner.org/resources/series66.html?pop=yes&vodid=84574&pid=172#

Interactive Algebra Basics Tutorial
http://www.mathdork.com/

Interactive Math of Beauty Tutorial
http://www.intmath.com/BasicAlg/mathOfBeauty.php

What do you think?
APPENDIX K

SAMPLE INFORMATION AND CONSENT FORMS

Adolescent (14-18) Information Form

Dear Student,

My name is June Talvitie-Siple and I am a doctoral candidate in the School of Education at the University of North Carolina at Chapel Hill, NC. My specialization is in distance education and technology in the classroom. I am particularly interested in how distance education is developed for the K-12 student.

I have chosen the [your virtual high school] as the site for my dissertation research. To complete this research I need your participation. Even if you give permission, your parents may choose to not allow you to participate for any reason. I have outlined below information that will help you to understand the research study and what would be asked of you in the study.

The purpose of this research study is to learn about how high school students perceive their learning experience in a virtual high school and how these perceptions are related to academic performance and individual characteristics of students. Since virtual high schools are being developed in nearly every state in the United States, this information is important so that teachers, course developers, and administrators can make informed decisions on designing courses in the future.

Since you are enrolled in the [virtual high school’s] Algebra I course, I am asking you to take part in this research study. I anticipate that you will be one of approximately 25 students who will participate in the study. To join the study is voluntary. You may refuse to give permission for any reason. Your parents may also refuse to allow you to participate in the study.

This research study is intended to find out about students’ reactions to distance education courses and is not intended to benefit participants. The published results may be used in the development of future courses at the school. Participants in this study may take pride in helping to identify information that may improve courses for future students at this school and perhaps at other virtual high schools. You will receive between $25 and $35 for taking part in this study. There are five surveys in this study and some students will be asked to participate in interviews. If you complete all five surveys, but you do not participate in the interview process, you will receive $25. All five surveys must be completed. If you also participate in the interviews, you will receive $5 for each interview completed. Interview participants will be chosen by me.
There will be no monetary costs to you to participate. In addition, you will not be forced to change classrooms or teachers during the study. You will be expected to participate normally in the course, meeting all teacher requirements. Thus, you will be required to complete any assignments required by the teacher during the semester. This study will make every effort not to interfere with the flow of the course.

You will participate in the study during the Fall 2006 semester, from approximately August through December, 2006. You will be asked to complete five surveys, each taking approximately 20-30 minutes. These surveys will be administered during the weekly online class meetings. You may be asked to participate in online interviews. Each interview may take approximately 30-45 minutes. If selected, you will be asked to participate in at least one interview and perhaps an additional follow-up interview. You may refuse to participate in any interview for any reason. In addition, your previous final mathematics grade (8th grade or after if you are no longer in 9th grade), as well as those grades you receive in Algebra I will be collected as part of the research study.

A risk to you may be the release of personal information during the collection of the data. Due to the study design and the precautions in place, this risk is extremely low. You will be assigned a pseudonym so that no one viewing your information will be able to identify you, except me. Only I will know who is assigned to which pseudonym.

The location of the site will not be revealed in any publication. During the study, no results or data will be shared with anyone, including your teacher, at any time. After the study, you, your parents, the district, the school, or your teacher may request a copy of the final publication, but only pseudonyms will be used in the final publication.

If you encounter an unforeseen problem you should report the problem to me at the phone number or email listed above.

You have the right to ask, and have answered, any questions you may have about this research. If you have questions, or concerns, you should contact me at [phone number] or [email address]. You can also have your parents contact me.

All research on human volunteers is reviewed by a committee that works to protect your rights and welfare. If you have questions or concerns about your rights as a research subject you may contact, anonymously if you wish, the Institutional Review Board at [phone number] or by email to [email address].

It is important that you understand this information so that you can make an informed choice about giving your permission to be in this research study. For your records, you will be given a copy of this letter and your consent form.
Dear Parent and/or Guardian,

My name is June Talvitie-Siple and I am a doctoral candidate in the School of Education at the University of North Carolina at Chapel Hill, NC. My specialization is in distance education and technology in the classroom. I am particularly interested in how distance education is developed for the K-12 student.

I have chosen the [district virtual high school] as the site for my dissertation research. To complete this research I am asking you for permission to have your child participate. Even if you give permission, your child may choose not to participate for any reason. I have outlined below information that will help you to understand the research study and what would be asked of your child in the study.

The purpose of this research study is to learn about how high school students perceive their learning experience in a virtual high school and how these perceptions are related to academic performance and individual characteristics of students. Since virtual high schools are being developed in nearly every state in the United States, this information is important so that teachers, developers, and administrators can make informed decisions on designing courses in the future.

Since your child is enrolled in the [virtual high school’s] Algebra I course, I am asking you to allow your child to take part in this research study. I anticipate that your child will be one of approximately 25 students who will participate in the study. To join the study is voluntary. You may refuse to give permission, or you may withdraw your permission for your child to be in the study, for any reason. Even if you give your permission, your child can decide not to be in the study or to leave the study early.

This research study is intended to find out about students’ reactions to distance education courses and is not intended to benefit participants. The published results may be used in the development of future courses at the school. Participants in this study may take pride in helping to identify information that may improve courses for future students at this school and perhaps at other virtual high schools. Your child will receive between $25 and $35 for taking part in this study. There are five surveys in this study and some students will be asked to participate in interviews. If your child completes all five surveys, but does not participate in the interview process, your child will receive $25. All five surveys must be completed. If your child also participates in the interviews, your child will receive $5 for each interview completed. Interview participants will be chosen by me.

There will be no monetary costs to you or your child to participate. In addition, your child will not be forced to change classrooms or teachers during the study. Your child will be expected to participate normally in the course, meeting all teacher requirements. Thus, your child will be required to complete any assignments required by the teacher during the semester. This study will make every effort not to interfere with the flow of the course.
Your child will participate in the study during the Fall 2006 semester, from approximately August through December, 2006. Your child will be asked to complete five surveys, each taking approximately 20-30 minutes. These surveys will be administered during the weekly online class meetings. Your child may be asked to participate in online interviews. Each interview may take approximately 30-45 minutes. If selected, your child will be asked to participate in at least one interview and perhaps an additional follow-up interview. Your child may refuse to participate in any interview for any reason. In addition, your child’s mathematics grades from the previous year as well as those grades your child receives in Algebra I will be collected as part of the research study.

A risk to your child may be the release of personal information during the collection of the data. Due to the study design and the precautions in place, this risk is extremely low. Your child will be assigned a pseudonym so that no one viewing his or her information will be able to identify your child, except me. Only I will know who is assigned to which pseudonym.

The location of the site will not be revealed in any publication. During the study, no results or data will be shared with anyone, including your child’s teacher, at any time. After the study, you, your child, the district, the school, or the teacher may request a copy of the final publication, but only pseudonyms will be used in the final publication.

Another problem that may arise is the time it will take the students to complete the surveys and interviews during the study. Every effort will be made to reduce the amount of time the students will require to complete their participation tasks. If necessary, alternative arrangements may be made to allow the students to complete their surveys outside of class time. Interviews will not be conducted during class time.

If you or your child encounters an unforeseen problem you should report the problem to me at the phone number or email listed above.

You have the right to ask, and have answered, any questions you may have about this research. If you have questions, or concerns, you should contact me at [phone number] or [email address].

All research on human volunteers is reviewed by a committee that works to protect your rights and welfare. If you have questions or concerns about your child’s rights as a research subject you may contact, anonymously if you wish, the Institutional Review Board at [phone number] or by email to [email address].

It is important that you understand this information so that you can make an informed choice about giving permission for your child to be in this research study. For your records, you will be given a copy of this letter and both your consent form and your child’s consent form.
Adolescent Participants age 14-18

Social Behavioral Form

What are some general things you should know about research studies?
You are being asked to take part in a research study. Your parent, or guardian, needs to give permission for you to be in this study. You do not have to be in this study if you don’t want to, even if your parent has already given permission. To join the study is voluntary. You may refuse to join, or you may withdraw your consent to be in the study, for any reason, without penalty.

Research studies are designed to obtain new knowledge. This new information may help people in the future. You may not receive any direct benefit from being in the research study. There also may be risks to being in research studies.

Details about this study are discussed below. It is important that you understand this information so that you can make an informed choice about being in this research study. You will be given a copy of this consent form. You should ask the researchers named above, or staff members who may assist them, any questions you have about this study at any time.

What is the purpose of this study?
The purpose of this research study is to learn about how high school students perceive their learning experience in a virtual high school and how these perceptions are related to academic performance and individual characteristics of students. Since virtual high schools are being developed in nearly every state in the United States, this information is important so that teachers, course developers, and administrators can make informed decisions on designing courses in the future.

You are being asked to be in the study because you are enrolled in Algebra I at your school district’s virtual high school. Because of your enrollment in this course, your perceptions and opinions are important to this study.

How many people will take part in this study?
If you decide to be in this study, you will be one of approximately 26 people in this research study. There will be approximately 25 students and one teacher.

How long will your part in this study last?
Your part in the study will be during the Fall 2006 semester, from approximately August through December, 2006.

What will happen if you take part in the study?
If you participate in the study,

1. You will be asked to participate in the course as you would do normally. Thus,
you will be required to complete any assignments required by your teacher during the semester. This study will make every effort not to interfere with the flow of the course.

2. Your previous final mathematics grade(s) (8th grade or after if you are no longer in 9th grade), as well as those grades you receive in Algebra I will be obtained from your Algebra teacher.

3. You will complete five surveys that will ask about your attitudes during your online Algebra course. You may choose not to answer any question on the surveys for any reason.

4. Your participation both in WebCT and in the weekly Centra session will be recorded, as is typical for this course. These recordings may be evaluated by the researcher during the study.

5. You may be asked to participate in an interview. You have the right to refuse to participate in the interview.

What are the possible benefits from being in this study?
The research study is intended to find out about students’ reactions to distance education courses and is not intended to benefit participants. The published results may be used in the development of future courses at the site. Participants in this study may take pride in helping to identify information that may improve courses for future students at this school and perhaps at other virtual high schools.

What are the possible risks or discomforts involved from being in this study?
A risk to you may be the release of personal information during the collection of the data. Due to the study design and the precautions in place, this risk is extremely low.

There may be uncommon or previously unknown risks. You should report any problems to the researcher.

How will your privacy be protected?
Every effort will be made to protect your privacy. To protect the privacy of each participant, including you, all names will be replaced on all documents with a pseudonym to conceal the identities of the participants. Only the pseudonyms the researcher assigns to the participants will be used in any presentation of this research to others. The specific location of the site will not be revealed in any publication. All data from the study, including the names and pseudonyms of the participants, will be stored on a password-protected CD (compact disk). The CD will be stored in a locked cabinet in a locked office at the university. Only the researcher will have access to the CD.

During the study, no results or data will be shared with anyone, including your teacher, at any time. After the study is published, you, your parents, the district or school officials, or your teacher may request a copy of the final publication.

Participants will not be identified in any report or publication about this study. Although every effort will be made to keep research records private, there may be times when federal or state law requires the disclosure of such records, including personal
information. This is very unlikely, but if disclosure is ever required, UNC-Chapel Hill will take steps allowable by law to protect the privacy of personal information. In some cases, your information in this research study could be reviewed by representatives of the University, research sponsors, or government agencies for purposes such as quality control or safety.

**Will you receive anything for being in this study?**
This research study is intended to find out about students’ reactions to distance education courses and is not intended to benefit participants. The published results may be used in the development of future courses at the school. Participants in this study may take pride in helping to identify information that may improve courses for future students at this school and perhaps at other virtual high schools. You will receive between $25 and $35 for taking part in this study. There are five surveys in this study and some students will be asked to participate in interviews. If you complete all five surveys, but you do not participate in the interview process, you will receive $25. All five surveys must be completed. If you also participate in the interviews, you will receive $5 for each interview completed. Interview participants will be chosen by the researcher.

**Will it cost you anything for you to be in this study?**
There will be no costs for being in the study.

**What if you have questions about this study?**
You have the right to ask, and have answered, any questions you may have about this research. If you have questions, or concerns, you should contact the researchers listed on the first page of this form.

**What if you have questions about your rights as a research participant?**
All research on human volunteers is reviewed by a committee that works to protect your rights and welfare. If you have questions or concerns about your rights as a research subject you may contact, anonymously if you wish, the Institutional Review Board at [phone number] or by email to [email address].

**Principal Investigator:** June Talvitie-Siple

**Participant’s Agreement:**
I have read the information provided above. I have asked all the questions I have at this time. I voluntarily agree to participate in this research study.

_________________________________________   _________________
Your signature if you agree to be in the study    Date

_________________________________________
Printed name if you agree to be in the study
What are some general things you should know about research studies?
You are being asked to allow your child to take part in a research study. To join the study is voluntary. You may refuse to give permission, or you may withdraw your permission for your child to be in the study, for any reason. Even if you give your permission, your child can decide not to be in the study or to leave the study early.

Research studies are designed to obtain new knowledge. This new information may help people in the future. Your child may not receive any direct benefit from being in the research study. There also may be risks to being in research studies.

Details about this study are discussed below. It is important that you understand this information so that you and your child can make an informed choice about being in this research study.
You will be given a copy of this permission form. You and your child may ask the researchers named above any questions you or your child have about this study at any time.

What is the purpose of this study?
The purpose of this research study is to learn about how high school students perceive their learning experience in a virtual high school and how these perceptions are related to academic performance and individual characteristics of students. Since virtual high schools are being developed in nearly every state in the United States, this information is important so that teachers, course developers, and administrators can make informed decisions on designing courses in the future.

Your child is being asked to be in the study because he or she is enrolled in an Algebra I course offered through your school district’s virtual high school. Because of this enrollment in the course, your child’s perceptions and opinions are important to this study.

How many people will take part in this study?
If your child is in this study, your child will be one of approximately 26 people in this research study. There will be approximately 25 students and one teacher.

How long will your child’s part in this study last?
Your child will participate in the study during the Fall 2006 semester, from approximately August through December, 2006.

What will happen if your child takes part in the study?
If your child participates in the study,

1. Your child will be asked to participate in the course as he or she would do
normally. Thus, your child will be required to complete any assignments required by the teacher during the semester. This study will make every effort not to interfere with the flow of the course.

2. Your child’s previous final mathematics grade (8th grade or after if you are no longer in 9th grade), as well as those grades your child receives in Algebra I will be obtained from your child’s Algebra teacher.

3. Your child will complete five surveys that will ask about your child’s attitudes during his or her online Algebra course. Your child may choose not to answer any question on the surveys for any reason.

4. Your child’s participation both in WebCT and in the weekly Centra session will be recorded, as is typical for this course. These recordings may be evaluated by the researcher during the study.

5. Your child may be asked to participate in an interview. Your child has the right to refuse to participate in the interview.

**What are the possible benefits from being in this study?**

The research study is intended to find out about students’ reactions to distance education courses and is not intended to benefit participants. The published results may be used in the development of future courses at the school. Participants in this study may take pride in helping to identify information that may improve courses for future students at this school and perhaps at other virtual high schools.

**What are the possible risks or discomforts involved from being in this study?**

A risk to your child may be the release of personal information during the collection of the data. Due to the study design and the precautions in place, this risk is extremely low.

Another problem that may arise is the time it will take the students to complete the surveys and interviews during the study. Every effort will be made to reduce the amount of time your child will require to complete their participation tasks. If necessary, alternative arrangements may be made to allow your child to complete his or her surveys outside of class time. Interviews will not be conducted during class time.

There may be uncommon or previously unknown risks. You should report any problems to the researcher.

**How will your child’s privacy be protected?**

Every effort will be made to protect your child’s privacy. To protect the privacy of each participant, including your child, all names will be replaced on all documents with a pseudonym to conceal the identities of the participants. Only the pseudonyms the researcher assigns to the participants will be used in any presentation of this research to others. The specific location of the site will not be revealed in any publication. All data from the study, including the names and pseudonyms of the participants, will be stored on a password-protected CD (compact disk). The CD will be stored in a locked cabinet in a locked office at the university. Only the researcher will have access to the CD.

During the study, no results or data will be shared with anyone, including your child’s
teacher, at any time. After the study is published, you, your child, the district or school officials, or your child’s teacher may request a copy of the final publication.

Participants will not be identified in any report or publication about this study. Although every effort will be made to keep research records private, there may be times when federal or state law requires the disclosure of such records, including personal information. This is very unlikely, but if disclosure is ever required, UNC-Chapel Hill will take steps allowable by law to protect the privacy of personal information. In some cases, your child’s information in this research study could be reviewed by representatives of the University, research sponsors, or government agencies for purposes such as quality control or safety.

**Will your child receive anything for being in this study?**
Your child will receive between $25 and $35 for taking part in this study. There are five surveys in this study and some students will be asked to participate in interviews. If your child completes all five surveys, but does not participate in the interview process, your child will receive $25. All five surveys must be completed. If your child also participates in the interviews, your child will receive $5 for each interview completed. Interview participants will be chosen by the researcher.

**Will it cost you anything for your child to be in this study?**
There will be no costs for being in the study.

**What if you or your child has questions about this study?**
You and your child have the right to ask, and have answered, any questions you may have about this research. If you have questions, or concerns, you should contact the researchers listed on the first page of this form.

**What if you or your child has questions about your child’s rights as a research participant?**
All research on human volunteers is reviewed by a committee that works to protect your child’s rights and welfare. If you or your child have questions or concerns about your child’s rights as a research subject you may contact, anonymously if you wish, the Institutional Review Board at [phone number] or by email to [email address].

**Parent’s Agreement:**
I have read the information provided above. I have asked all the questions I have at this time. I voluntarily give permission to allow my child to participate in this research study.

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Dear Teacher,

My name is June Talvitie-Siple and I am a doctoral candidate in the School of Education at the University of North Carolina at Chapel Hill, NC. My specialization is in distance education and technology in the classroom. I am particularly interested in how distance education is developed for the K-12 student.

I have chosen the [district virtual high school] as the site for my dissertation research. To complete this research I need your participation. I have outlined below information that will help you to understand the research study and what would be asked of you in the study.

The purpose of this research study is to learn about how high school students perceive their learning experience in a virtual high school and how these perceptions are related to academic performance and individual characteristics of students. Since virtual high schools are being developed in nearly every state in the United States, this information is important so that teachers, course developers, and administrators can make informed decisions on designing courses in the future.

Since you are the teacher for the online Algebra I course at the [virtual high school], I am asking you to participate in this research study. To join the study is voluntary. You may refuse to give permission for any reason. This research study is intended to find out about students’ reactions to distance education courses and is not intended to benefit participants. There will be no monetary costs to you to participate.

The published results may be used in the development of future courses at the school. Participants in this study may take pride in helping to identify information that may improve courses for future students at this school and perhaps at other virtual high schools. Your participation is crucial to the success of this study.

If you choose to participate in the study during the Fall 2006 semester, from approximately August through December, 2006. I will ask you:

1. To teach the course as you would do normally. This study will make every effort not to interfere with the flow of the course or your teaching.
2. To assure your students that their participation in this research study will have no effect on their grades during or at the end of the course,
3. For your assistance in gathering your students’ previous final mathematics grades (8th grade and after if the student is no longer in 9th grade), as well as those grades you give to your students in Algebra I. These data will be collected as part of the research study.
4. For your permission to sit in on your synchronous classroom sessions in Centra and to download the recording of each session.
5. For access to the WebCT classroom so that I might observe the interaction and
level of participation of your students in the asynchronous portion of your course.
6. To participate in one or more online interviews. Each interview may take approximately 30-45 minutes.

The only risk specific to you may be the release of personal information during the collection of the data. Due to the study design and the precautions in place, this risk is extremely low. Your students will understand that you are aware of this research study and that you have agreed to participate. Thus, your participation cannot be hidden from the students, their parents, and your administration. However, no personal information or conversations between you and me will be shared with your students or their parents. Each participant, including you, will be assigned a pseudonym and I will be the only one who will know which participant in the study was assigned which pseudonym. Only the pseudonym I assign to the participants will be used in any presentation of this research to others.

The specific location of the site will not be revealed in any publication. During the study, no results or data will be shared with anyone, including you, at any time. It is necessary to emphasize that no information will be shared with you on what your students report either in the form of the surveys or personal interviews. This will help to assure your students that their privacy is not breached while they are still your students. After the study is published, you, the district or school officials, or your students may request a copy of the final publication. Only pseudonyms will be used in the final publication.

Another problem that may arise is the time it will take the students to complete the surveys and interviews during the study. Every effort will be made to reduce the amount of time the students will require to complete their participation tasks. If necessary, alternative arrangements may be made to allow the students to complete their surveys outside of class time. Interviews will not be conducted during class time.

If you encounter an unforeseen problem you should report the problem to me at the phone number or email listed above.

You have the right to ask, and have answered, any questions you may have about this research. If you have questions, or concerns, you should contact me at [phone number] or [email address].

All research on human volunteers is reviewed by a committee that works to protect your rights and welfare. If you have questions or concerns about your rights as a research subject you may contact, anonymously if you wish, the Institutional Review Board at [phone number] or by email to [email address].

It is important that you understand this information so that you can make an informed choice about giving your permission to be in this research study. For your records, you will be given a copy of this letter and your consent form.
Adult Participants—Teacher

Social Behavioral Form

**What are some general things you should know about research studies?**
You are being asked to take part in a research study. To join the study is voluntary. You may refuse to join, or you may withdraw your consent to be in the study, for any reason, without penalty.

Research studies are designed to obtain new knowledge. This new information may help people in the future. You may not receive any direct benefit from being in the research study. There also may be risks to being in research studies.

Details about this study are discussed below. It is important that you understand this information so that you can make an informed choice about being in this research study.

You will be given a copy of this consent form. You may ask the researchers named above any question you have about this study at any time.

**What is the purpose of this study?**
The purpose of this research study is to learn about how high school students perceive their learning experience in a virtual high school and how these perceptions are related to academic performance and individual characteristics of students. Since virtual high schools are being developed in nearly every state in the United States, this information is important so that teachers, course developers, and administrators can make informed decisions on designing courses in the future.

You are being asked to be in the study because you are the teacher for the online Algebra I at your school district’s virtual high school. Your cooperation will provide valuable information about the structure of your course. In addition, your cooperation will help put your students’ concerns at ease.

**How many people will take part in this study?**
If you decide to be in this study, you will be one of approximately 26 people in this research study. There will be approximately 25 students and you, as the teacher.

**How long will your part in this study last?**
You will participate in the study during the Fall 2006 semester, from approximately August through December, 2006.

**What will happen if you take part in the study?**
If you choose to participate in the study during the Fall 2006 semester, from approximately August through December, 2006. I will ask you:

1. To assure your students that their participation in this research study will have no effect on their grades during or at the end of the course,
2. For your assistance in gathering your students’ previous final mathematics grade
(8th grade or after if they are no longer in ninth grade), as well as those grades you give to your students in Algebra I. This data will be collected as part of the research study.

3. For your permission to sit in on your synchronous classroom sessions in Centra and to download the recording of each session.

4. For access to the WebCT classroom so that I might observe the interaction and level of participation of your students in the asynchronous portion of your course.

5. To participate in one or more online interviews. Each interview may take approximately 30-45 minutes.

The following is an outline of what will happen with your students who take part in the study.

At the beginning of the semester:

1. You will be asked to provide your students’ previous final mathematics grades (8th grade and after if they are no longer in 9th grade) for the study during the first two weeks of the semester. In terms of this study, you are to share this information only with the researcher to protect your students’ privacy. These grades will be used to evaluate mathematics achievement in the past.

2. Your students will complete a survey about their attitudes about mathematics. This survey will include a short section that will ask about your students’
   a. Email address,
   b. Age,
   c. Grade,
   d. Gender,
   e. Race,
   f. Ethnicity,
   g. Reason for taking a virtual high school course,
   h. Reason for taking an Algebra I course,
   i. Expectations about the course,
   j. Experience in virtual courses, and
   k. Comfort level using computers and other technologies.

3. Your students may choose not to answer any question on the survey for any reason.

4. Your students will be asked to participate normally in their classes, meeting all teacher requirements. Thus, your students will be required to complete any assignments required by you during the semester. This study will make every effort not to interfere with the flow of the course.

During the middle of the semester:

1. Your students’ mid-semester grades in the course will be obtained for the study from your records. These grades will be used to evaluate your students’ ongoing mathematics achievement.

2. Your students' participation both in WebCT and in the weekly Centra session will
be monitored, recorded, and examined to identify any patterns of participation.

3. Some of your students may be asked to participate in an interview. If one of your students is chosen for an interview, he or she has the right to refuse to participate in the interview. If he or she agrees to participate in the interview, he or she will be contacted to determine an appropriate time and day that is convenient to your student. Once the time is determined, your student will participate in an interview with the researcher using your secured Internet classroom (Centra) provided by the school.

4. The recorded interview will be downloaded to the researcher’s computer, transcribed, and then the original downloaded file will be destroyed so that it will not be available to anyone other than the researcher. All names of the participants in the transcript will be replaced with their corresponding pseudonym.

Near the end of the semester:

1. Your students will complete four surveys over the course of the last few weeks of the semester. Your students may choose not to answer any questions on these surveys for any reason.

2. Your students’ final grades will be obtained for the study from your records. These grades will be used to evaluate your students’ final mathematics achievement.

3. If some of your students participated in an interview during the semester, they may be asked to participate in a follow-up interview to clarify any questions that might arise at the end of the semester. The students have the right to refuse to participate in any follow-up interview.

During the study, no results or data will be shared with you at any time. No information will be shared with you on what your students report either in the form of the surveys or personal interviews. Once the study is published, you are welcome to request a copy of the published article. This will help to assure your students that their privacy is not breached while they are still your students.

**What are the possible benefits from being in this study?**

The research study is intended to find out about students’ reactions to distance education courses and is not intended to benefit participants. The published results may be used in the development of future courses at the site. Participants in this study may take pride in helping to identify information that may improve courses for future students at this school and perhaps at other virtual high schools.

**What are the possible risks or discomforts involved from being in this study?**

The only risk specific to you may be the release of personal information during the collection of the data. Due to the study design and the precautions in place, this risk is extremely low.

Another problem that may arise is the time it will take the students to complete the surveys and interviews during the study. Every effort will be made to reduce the amount
of time your students will require to complete their participation tasks. If necessary, alternative arrangements may be made to allow the students to complete their surveys outside of class time. Interviews will not be conducted during class time.

There may be uncommon or previously unknown risks. You should report any problems to the researcher.

**How will your privacy be protected?**
Every effort will be made to protect your privacy. To protect the privacy of each participant, including you, all names will be replaced on all documents with a pseudonym to conceal the identities of the participants. Only the pseudonyms the researcher assigns to the participants will be used in any presentation of this research to others. The specific location of the site will not be revealed in any publication. Of course, the district and the school officials will be aware of the research study and which set of students will participate. Since you are the only teacher participating, your identity within the district will not be protected. Your students and their parents, and the district and school officials will know your identity. However, all data from the study, including the names and pseudonyms of the participants, will be stored on a password-protected CD (compact disk). The CD will be stored in a locked cabinet in a locked office at the university. Only the researcher will have access to the CD. During the study, no results or data will be shared with any participant at any time. After the study is published, you, the district or school officials, or your students and their parents may request a copy of the final publication.

Participants will not be identified in any report or publication about this study. Although every effort will be made to keep research records private, there may be times when federal or state law requires the disclosure of such records, including personal information. This is very unlikely, but if disclosure is ever required, UNC-Chapel Hill will take steps allowable by law to protect the privacy of personal information. In some cases, your information in this research study could be reviewed by representatives of the University, research sponsors, or government agencies for purposes such as quality control or safety.

**Will you receive anything for being in this study?**
Your participation is crucial to the success of this study. You will be paid by the District at its daily rate of pay for after hours work up to $100. The District will be reimbursed for those costs by the researcher.

**Will it cost you anything to be in this study?**
There will be no monetary costs to you for being in the study.

**What if you have questions about this study?**
You have the right to ask, and have answered, any questions you may have about this research. If you have questions, or concerns, you should contact the researchers listed on the first page of this form.
What if you have questions about your rights as a research participant?
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I have read the information provided above. I have asked all the questions I have at this time. I voluntarily agree to participate in this research study.

_________________________________________   _________________
Signature of Research Participant     Date

_________________________________________
Printed Name of Research Participant