

EFFECTS OF ONLINE MATH INSTRUCTION

By Jodi Maga-Daniels

The world of education is changing tremendously due to the vast amount of technology integration being applied in schools. One of the most significant changes is the method of instructional delivery. Online or virtual schools are becoming increasingly popular and accepted as an alternative to brick and mortar schools where not all students are able to perform to their fullest potential. This popularity is due to many factors, including convenience of course schedules, engaging format for students who are interested in computer technology, and attending an alternative environment for students experiencing social anxiety or behavioral concerns. Many students who choose to attend virtual schools are students with disabilities. This alternate environment can be positive for the highly motivated or self-directed learners, but perhaps not so positive for students who are not internally motivated or students who need more applied instruction or continual contact to be successful. Another consideration is that in some subjects such as math, students may need to be able to ask teachers questions as they arise or be presented materials in a hands-on way in order to learn and understand. Since math is often viewed as a paper and pencil task, this trend towards virtual schooling begs the question how receiving online instruction affects the learning of students in math class.

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by

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To Henry, who inspires me every day to be the best mother and teacher I can be. May I inspire you to reach your fullest potential and believe anything is possible with hard work and determination.

To Shawn, who encouraged me to finish my endeavors. Thank you for letting me live my dreams.

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CHAPTER I

INTRODUCTION

Research Question

Do students' math scores improve more in a virtual setting than they did in a brick and mortar setting?

Background

Virtual schools have become increasingly popular, not only as an alternative for high school students, but for all students kindergarten through grade twelve. Although growth in their numbers can be seen as an extension of correspondence courses or distance learning of the past century, virtual schools have evolved into schools that meet the needs of the twenty-first century students (Hannum, Irvin, Banks, & Farmer, 2009). Virtual schools operate much the way that traditional brick and mortar schools do, but with many variations that make them distinct from traditional schools and each other. Many virtual schools operate under the auspices of local public school districts, some as charter schools. The popularity of virtual schools has caused quite a stir, and even controversy, in the world of traditional education. Many educators question their validity, effectiveness, and the overall legitimacy of their place in K-12 education (Glass & Welner, 2011). However, more and more school districts are recognizing virtual learning as a legitimate way to engage otherwise reluctant learners and credit recovery for students who are credit deficient, as demonstrated by the increase in the number of

virtual schools that have opened their doors in the last 15-20 years. The virtual environment is increasingly recognized as an alternative to meet the needs of students and to address their unique learning styles.

The virtual school represented in this study came into existence in the early 2000s. It is located in an upper Midwestern state and has been operating under its current charter through a small. The virtual school had approximately 800 students enrolled at the high school level. Of that number, approximately 115 students were students identified with special education needs who had Individual Education Plans (IEPs). Approximately 14.375% of the high school student population was found in need of special education services, compared to the national average of roughly 13% in the 2009-2010 school year (Institute of Education Science, 2012).

The author of this study was a high school special education teacher at the virtual school, whose caseload was comprised of ninth through twelfth grade students with special education needs. Of specific interest to the author was how online mathematics instruction affected the learning and math skills of high school students receiving special education services. The author noticed that many of her students did not have the requisite skills to complete high school algebra and geometry. For those students with relatively low skill sets in mathematics, prior interventions were either ineffective or perhaps not implemented with fidelity. This is of particular concern since the implementation of the Common Core State Standards will require the virtual school students to complete the course progression of algebra I, geometry, trigonometry, and algebra II (Common Core State Standards Initiative, 2012). Prior to the Common Core

expectation, students with low math skills or interests could be placed in foundational, basic, or applied math courses to meet graduation requirements. The necessity to have a baseline of math skills was never fully realized until now, since changing the expectation of the skill set does not resolve the fact that the students are not meeting a basic level of math proficiency.

Remedial instruction in all subjects poses a particularly interesting scenario at the high school level, as students complete coursework in exchange for high school credit. High school students in a brick and mortar school typically do not have the time in the course of their school day to complete remedial work, in addition to their course load expectations. Therefore, students with skill deficits have few opportunities to improve those skill areas at the high school level. Whether a high school student attends a brick and mortar school or a virtual school, it was the observation of this special education teacher that students with math deficits did not improve their math skills to grade level expectations by graduation. In addition, high school students with special education needs were even less likely to make up for the math skills deficits, as their expectations and level of instruction were often modified based on the students' present levels of academic achievement. These students were placed in lower level math classes, provided with accommodations that often did not challenge them, and continued along a path that did not ensure the student made the gains to be at grade level upon graduation (Woodward, 1999). In fact, students with disabilities who have deficits in math "show growth patterns in mathematics of only 1 year for every 2 or more years of school" (Calhoon & Fuchs, 2003). Typical accommodations for student with special education

needs in math include unmitigated use of a calculator and use of multiplication charts. Such tools, while helpful to students in the short-term, ensure these students enter and attend high school lacking automaticity in basic math calculation skills (Woodward, 1999).

Theoretical Framework of the Researcher

Psychologist Albert Bandura's social cognitive theory was used as the foundation for this study. This theory posits that learning stems from the observation of others. A major component of Bandura's theory is self-efficacy (Bandura, 1977). Self-efficacy can be described as one's personal beliefs in one's ability to succeed in a given situation or assigned task. It is the belief of this researcher and the belief of Bandura that levels of self-efficacy contribute to the academic achievement and tend to indicate academic effort students will demonstrate. People become anxious and avoidant in situations where they feel they do not have the requisite skills to be successful in a given task. In contrast, people will present as engaged, cooperative, and actively involved in tasks that are within their perceived level of capability. This perceived level of capability is self-efficacy. As the concept of self-efficacy is applied to children and education, a student with a high level of self-efficacy would view difficult subject areas as a challenge to work through rather than avoid, whereas a child with a low sense of self-efficacy might view subjects that are difficult as not worth putting forth effort because they will likely never master them.

The Common Core State Standards for Mathematical Practices recommends that all math educators address important “practices and proficiencies” in math education, that includes, among other elements, a “productive disposition” (Common Core State Standards Initiative, 2012, p. 6). This disposition is defined as the “habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one’s own efficacy” (p. 6). With the recent widespread adoption of the Common Core State Standards, accountability for math performance emphasizes perseverance and self-efficacy in mathematical problem solving, as much as it does specific skills and concepts. This is a positive change from practices in math instruction that only stresses outcomes, concepts, and performance data. This is especially good news for students with special education needs, as overcoming an absence of positive beliefs in one’s own abilities is a significant obstacle in all learning. The standards promise to be a new approach to reform of our mathematics expectations for k-12 learners.

Purpose and Scope

The purpose of this study was to determine how the skills of high school students with special education needs were affected by online instruction in math and how those students’ attitudes about math paired up with their skill levels. This study included ninth, tenth, eleventh, and twelfth grade students with special education needs who attended the virtual school. Students were interviewed about their experiences and perceived skill levels in mathematics in both the virtual and brick and mortar learning environments. Students were randomly assigned a number and identified by their grade level, gender,

area of disability, and math grades. In addition, these students' math grades, Scantron Performance Series Assessment, and standardized state test scores (if available) were analyzed to determine math skill levels.

Definition of Terms

- *Brick and mortar* refers to the traditional school building where students physically attend school.
- *Synchronous* refers to instruction that is time delimited and teacher facilitated in a live format.
- *Asynchronous* refers to instruction that is student directed and paced and is not considered live instruction.
- *Just-in-time* refers to having questions or problems arise and clarification occurs at the moment of occurrence and as needed.

Summary

The virtual k-12 school setting is quickly becoming an alternate educational option for students in the United States, as not only a place to attend school, but a place where it is expected that all students, including those with disabilities, make real educational gains and prepare for the demands of a 21st century global society. The traditional brick and mortar school system has been in place in the United States for over 100 years, but only more recently have students with disabilities been mainstreamed into the general education classrooms. In addition, this new, virtual setting has only been in

existence for approximately two decades. Given the newness of the virtual school setting and technology driven method of instruction, the effectiveness of virtual schools deserves analysis and review to determine their usefulness and their place in the education of children with disabilities. This study seeks to determine whether math scores of high school students with disabilities improved more in a virtual setting than they did in a brick and mortar setting. Chapter Two provides a framework for understanding the current underpinnings of virtual schools and computer-driven math instruction. The research that was conducted and shared in Chapter III Methods, and Chapter IV Results, attempts to fill some of these gaps in our understanding with regards to students with disabilities. The focus of Chapter V Discussion is application of the recommendations to actual students with disabilities attending virtual schools.

CHAPTER II

REVIEW OF LITERATURE

Although there are a number of meta-analytic studies involving virtual or online learning, related to online high school mathematics instruction, there are relatively few studies that address the effects specifically for students receiving special education services. The existing research regarding virtual learning attempts to address reasons for students taking and/or schools offering virtual learning opportunities (Hannum et al., 2009; Kronholz, 2011; Picciano, Seaman, Shea, & Swan, 2012), specific technology being used in virtual learning or used to enhance learning in brick and mortar schools (Beal, Qu, & Lee, 2008; Eid, 2005; Gardner & Wissick, 2002; Graves, Asunda, Plant, & Goad, 2011; King & Robinson, 2009; Lopez-Morteo & Lopez, 2005; Maloy, Edwards, & Anderson, 2010; Naidoo & Naidoo, 2007; Scarlatos, 2006; Shamir & Baruch, 2012; Smith & Ferguson, 2004), and attitudes and perceptions of academic performance among students involved in virtual learning (Kim, Kim, & Karimi, 2012; Oliver, Kellogg, & Patel, 2010; Zavarella & Ignash, 2009). Much of the research also involves elementary (Eid, 2005; Naidoo & Naidoo, 2007; Shamir & Baruch, 2012) or college students (Graves et al., 2009; King & Robinson, 2009; Wenner, Burn, & Baer, 2011), focuses on students in countries other than the United States (Brett, 2004; Eid, 2005; King & Robinson, 2009; Lopez-Morteo & Lopez, 2005; Naidoo & Naidoo, 2007; Shamir & Baruch, 2012), and does not fully address trends in specific student populations, such as minorities or students with disabilities.

Relevance of Virtual Learning

The world of education is changing tremendously due to the vast amounts of technology that is capable of being used in schools and in our homes. One of the most significant changes in k-12 education due to this explosion of technology is the method of instructional delivery. Distance learning has been around for about a century or so and has evolved into what we now refer to as online or virtual education (Hannum et al., 2009). Whereas location and distance from educational institutions was once a limiting factor in access to education, distance education, particularly online education has bridged that gap and allows more students greater accessibility to courses they may have been previously unable to attend. Not only are classes that are taught fully or partially (blended learning) online becoming increasingly prevalent, but entire schools comprised of virtual classes and learners have increased substantially in the past 10 years. Statistics indicate a dramatic growth of virtual learning, as a 2007 publication estimated approximately 700,000 students enrolled in at least one online or blended course during the 2005-2006 school year in the United States (Hannum et al., 2009). That number grew to 1,030,000 in the 2007-2008 academic year, 70% of whom are high school students. It was anticipated “that by the year 2016 about one-quarter of all high school courses will be online and that by the year 2019 about one-half of all high school courses will be online” (Picciano et al., 2012). With this vast and rapid growth comes a need for a research-based investigation into the effective implementation of online tools and learning, a better understanding why students choose online schooling, and perhaps most

important, a better understanding of the effects, including the advantages and the risks of online education.

Low Approval of Online Math Instruction

Another area of consideration in online learning is that in subjects such as math, one skill is required in order to build upon the next. According to Newton (2010, p. 1069) “secondary school mathematics curriculum is highly hierarchical in the sense that success in lower level mathematics is a prerequisite for moving on to higher level mathematics.” Students may need to be able to get clarification and further explanation from teachers as questions arise or be presented materials in a hands-on way in order to learn and understand. Since math is often viewed as a hands-on, paper and pencil task, and the virtual learning environment lends itself better to “language-based disciplines than they do for mathematics” (Smith & Ferguson, 2004, p. 681). This trend towards virtual schooling requires that we know precisely how receiving online instruction in math might affect the learning of students. Math is a subject area with relatively low approval in the online environment. Students attending a North Carolina virtual school were surveyed regarding the degree of satisfaction of their learning experiences in six subject areas, English, math, science, social studies, careers, and foreign languages. The students’ answers indicated that math was rated second to last in terms of how much they were learning when compared to face-to-face courses, and second to last as to whether they would recommend the course to other students. Foreign language was ranked last, but both math and foreign language received significantly lower rankings than the other

subjects, suggesting that something about the method of effective instruction in these two subject areas gets lost in the online environment (Oliver et al., 2010). Since math is a core subject area and it is almost certain that completion of a series of math classes are a requirement for high school graduation in any school setting, the study of the effects of online math instruction is warranted.

Effects of Online Instruction

Critics of online educational systems appear suspicious of the “novelty” of the virtual school movement and claim “only a patchwork of research studies attempting to describe the growth of virtual schools” (Glass & Welner, 2011, p. 2). They insist on evidence-based research and question the effectiveness of virtual schools in promoting academic achievement. Comprehensive meta-analysis concluded that distance learning, including online and blended learning, in general is as effective as face-to-face instruction (Cavanaugh, Gillan, Komrey, Hess, Blomeyer & North Central Regional Educational Lab, 2004). Further meta-analytic study conducted by the U.S. Department of Education concluded “that classes with online learning, (whether taught completely online or blended) on average produced stronger student learning outcomes than do classes with solely face-to-face instruction” (Evaluation of Evidence-Based Practices in Online Learning, 2010, p. 18). However, critics point out that neither comprehensive meta-analysis “examined test performance over an extended period of time, none attempted to compare outcomes for virtual and traditional *full-time* schooling, and none looked at a complete curriculum” (Glass & Welner, 2011, p. 5).

Effective Implementation of Math Online Tools and Learning

Much of the current research into the use of technology in mathematics instruction focuses on isolated use of interactive computer technology, rather than the effects and dynamics of math courses that are taught entirely online. When education in which technology components or online games were utilized in mathematical instruction, it was found that, in comparison with face-to-face instruction, the use of technology was as effective as face-to-face instruction (Zavarella & Ignash, 2009). In some cases, the use of technology had a greater positive impact on math performance than traditional methods of instruction. In one such study, a South African research team looked at the effects of an interactive and adaptive computer program to teach the concept of area to 20 fifth grade students from “disadvantaged socio-economic communities with minimal or no access to computers” (Naidoo & Naidoo, 2007, p. 84). This study concluded that the students who were exposed to the computer learning understood the mathematical concept of *area* better than those 20 students in the control group who learned by traditional methods that did not include the use of computer assisted technology.

Some studies suggest that the use of technology can somehow improve student performance simply because curriculum is presented in a way that captures the attention of children who are growing up in the age of technology better than the traditional instructional models do. A 2005 study of elementary students indicates that the use of technology in the mode of assessment may have a significant impact on performance. Fifth grade girls were administered identical assessments, however, one group was

administered an online math problem-solving test and another group took the same test in a paper based format. Groups were created randomly and determined to have a fair distribution of math skill levels. Despite all other factors being equal, the mean score of the group that took the online test was higher than the mean of those who took the paper based test, and the study showed a statistically significant difference between the two methods of test administration (Eid, 2005). This study suggested that simply by virtue of the use of technology, online learning could improve outcomes, perhaps by producing increased effort by students.

The recreational or entertainment factor in computer-assisted or online education may help to explain why students are more engaged and more motivated to learn mathematics when they are presented instruction in that way. A 2005 study of Mexican high school students determined that even students who rarely engaged in online gaming expressed a preference for the instruction and learning that included computer games. In this study, high school students were given the opportunity to learn new math concepts from interactive, multi-player online math games. Researchers “observed a very enthusiastic overall behavior among these students when they were introduced to on-line mathematical games, especially those with the multi-user arithmetic memory game” (Lopez-Morteo, & Lopez, 2007, p. 634). Students in this study clearly viewed their learning as being enhanced by the technology provided and demonstrated a greater motivation in learning mathematics. Although this study determined student perceptions, motivations, and opinions, it did not however indicate student performance being improved with the usage of the online computer technology.

The Need for Online Education

Picciano, et al surveyed American high schools to determine the reasons that they offered online and blended courses (2012). Although the survey did not address the reason students take online courses, it seems logical that high schools would offer online education opportunities in response to their students' needs and wants. Schools were surveyed about the important factors considered when offering online course. This study's highest responses were:

1. Provide courses that otherwise were not available
2. Permit students who failed a course to take it again- credit recovery
3. Provide additional Advanced Placement Courses
4. Provide for the needs of specific students

Additionally, online courses are helping small districts to offer classes to students that they otherwise could not offer to due to low enrollment. They also help to meet the needs of students in rural districts that were previously unmet. Small and rural districts in the United States may not have the ability to offer upper level, Advanced Placement (AP), or vocational courses due to limited resources, low student enrollment, and the inability to attract qualified teachers in elective content areas (Hannum et al., 2009). In the Hannum, et al study of 394 rural school districts in the United States, English, foreign languages, and math were the subjects most offered in the virtual environment.

Credit recovery for failing students is cited as another reason for the popularity of online courses. In a study of a Virginia online high school, it was found that at-risk students, those with "poor attendance, excessive tardiness, academic failure, apathy,

social issues, low motivation, and... pregnancy and poverty” were on average two years behind in academic credits (Kronholz, 2011, p. 27). Online education not only allowed students to make up courses that they failed, it allowed them to do so in shorter periods of time than traditional brick and mortar schools allowed courses to be completed. In online credit recovery programs, students can essentially work at an accelerated pace to make up for failed courses and lost time. The advantage for school districts in the area of credit recovery is the possibility of improved graduation rates, a goal established by *No Child Left Behind* legislation (Picciano et al., 2012).

The public have become increasingly aware that brick and mortar schools are places where not all students are achieving to their fullest potential. Parents, politicians, and communities have demanded improvement from our schools to meet the needs of all children (U.S. Department of Education, 2001; Rich, 2013). Online courses have the potential to allow students with specific learning needs to be successful. Many students who choose to attend virtual schools are students with disabilities. Students who are physically unable to attend a brick and mortar school due to illness or infirmity, students who demonstrate significant behavioral concerns, student who are bullied, and students with social anxiety issues are all students who could potentially benefit from the online learning environment. Public schools are continually being asked to adapt to meet the needs of a diverse student population, and online learning is one way schools are able to help meet those needs.

Students with Disabilities in the Math Online Learning Environment

Few studies have been conducted that attempt to determine the effects of online learning, and more specifically, online math learning for students with disabilities. In fact, one study admits "...nor do we know much about how full-time virtual school can or should serve special needs students" (Glass & Welner, 2011, p. 5). Interactive technology has been increasingly employed to improve outcomes for students with disabilities. A 2012 study of Israeli kindergarten students found that interactive e-books may have helped to improve the understanding of elementary math concepts for young learners in the emergence of early math skills. The 52 student participants had been identified as being at risk for learning disabilities. The experimental group members that were exposed to six learning sessions with the e-books showed a greater degree of improvement of their pre-intervention test to post-intervention test scores, when compared to a control group (Shamir, & Baruch, 2012).

A 2011 study of college students determined to have learning disabilities, Attention Deficit Disorder (ADHD), or both, concluded that access to asynchronous online recordings of course work and the use of Tablet PCs and digital pen technology by instructors had an impact on students' perceptions of their learning in math and science courses. Students perceived their understanding of the course content to be clearer, course information to be more organized, course content to be more convenient, their achievement to be better, and their ability to compensate for their disabilities to be improved (Graves, Asunda, Plant, & Goad, 2011). Interestingly, this study did not

include actual information on student achievement, only students' self-perceptions about skills and achievement.

Social Cognitive Theory, Self-Efficacy, & Self-Directed Learning

This study of the effects of the virtual environment on learning would not be complete without reference to the components of, and circumstances under which the researcher believes that learning occurs. As mentioned previously, Albert Bandura's social cognitive theory provides the foundation of this study. This theory, although refined by Bandura and others over the years, "is based on the principal assumption that psychological procedures, whatever their form, serve as means of creating and strengthening expectations of personal efficacy" (Bandura, 1977, p. 193). A person's level of efficacy is determined by four factors, personal experiences, witnessing the experiences of others, the suggestions of others about one's abilities, and the emotional response of a person to a given situation. Not all of these factors are equally impactful on efficacy, and one may have greater influence on efficacy than another. For example, one's personal experience with success or failure may have greater influence than what another person might suggest to be one's abilities. More precisely, if it suggested to a person by another that he or she should exhibit little difficulty with a given task and could easily succeed given one's skill set, but that person ultimately fails at the task, that experience of failure has a greater impact on the person's feelings of efficacy than does the suggestions made by the other person (1977). In fact, Bandura states, "suggestions can be readily extinguished by disconfirming experiences" (1977, p. 198). In addition,

one's emotionally charged response to a given situation can increase levels of anxiety, producing avoidance behaviors, resulting in reduced ability levels, and ultimately justification of the initial emotional response.

Bandura's research led to the understanding that self-efficacy had far-reaching consequences. Efficacy ultimately contributes to academic achievement, behaviors, and even future career aspirations (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996, 2001). Research suggests that students with low levels of efficacy settle in with peers who hold similarly low levels of efficacy, engage in troublesome behavioral, experience rejection by peers and disengage from academic endeavors, which in turn contributes to low academic performance. In addition, this low level of self-efficacy often leads to depression in students, another contributor of low academic achievement (Bandura et al., 1996). In contrast, students with high levels of self-efficacy work harder towards academic aspirations. They tend to associate with like-minded students, and less often engage in troublesome behaviors. Additionally, students with a strong sense of control over their learning experience greater academic success, it is believed through increased drive for academic pursuits and higher order thinking skills (Bandura et al., 1996). Students with strong academic efficacy also deem themselves to be capable in future careers in science, medicine, technology, education, business management, and art and literature (Bandura et al, 2001). Bandura et al. stated, "The stronger the students' beliefs in their efficacy, the more occupational options they consider possible, the greater interest they show in them, the better they prepare themselves educationally for different career

pursuits, and the greater their persistence and success in their academic coursework” (Bandura et al., 1996, p. 1207).

Schools in the 21st century are tasked with equipping students with the necessary skills to be successful in college and in the workplace. Students are expected to learn a greater amount of material, at an accelerated rate, and in a different manner with the use of technology than previous expectations held. In the 1996 study, Bandura et al prophesied,

In the not too distant future, students will be educating themselves increasingly with multimedia instruction presented electronically by master teachers outside the confines of the school. The knowledge gap will widen between good and poor self-directed learners. Some of the most innovative and productive research in the educational field is designed to provide new insights into the determinants and mechanisms of self-directed learning. (p. 1219)

The research team could not possibly have known how accurately their statement would describe the nature of learning in the virtual classroom. Virtual schools most certainly utilize electronically presented multimedia instructional methods outside of the traditional brick and mortar school setting. Math is the area of interest in this study due to its previously mentioned low levels of student approval in the virtual environment and because it is a core subject area in which most, if not all students are expected to participate. In addition, teachers in virtual schools are accountable to the Common Core State Standards that emphasize an increased level of self-directed learning in

mathematics. This study seeks to provide insight into how math learning occurs in that self-directed learning environment that Bandura et al. described (1996).

Summary

With the tremendous growth of virtual school education, studies have been initiated to determine the effects of online education. These studies can be considered to be in their infancy and in many ways, incomplete. There are few studies that focus on the effects for students with disabilities. In fact, mention of students with disabilities tends to be a side note or incidental information, rather than the focus of any study. The need for research into math instructional delivery in the online environment is indicated by the fact that math is often seen as a subject in which students demonstrate what they know by using paper and pencil to solve problems, and does not easily lend itself to successful presentation and demonstration in the virtual environment. In addition, by nature of the virtual learning environment, students must demonstrate some level of initiative and self-directed learning in order to be successful.

The literature suggests that the online learning environment has an equal or nominal effect when compared to outcomes in brick and mortar schools, not just in math, but in all core subject learning objectives. However, there is some evidence to support the idea that virtual learning or technology driven instruction improves student perceptions regarding math performance and motivation. The research that provides data outcomes for online or technology driven instruction does not provide us with students' perceptions of online learning in math, opinions about their abilities in math,

and their actual performances in math courses. The research that does provides us with student perceptions, does not address specific math outcomes for students with disabilities. Nearly 15% of all the high school students enrolled in the virtual school are students with a disability. Informal conversations with students revealed that many of them were attending virtual school due to the low levels of academic and social success at their local brick and mortar schools. Understanding this population's learning habits, skill sets, and perceptions will allow teachers to better meet the educational needs of all students, including those with disabilities. As many students with disabilities gravitate to the virtual learning environment, it seems reasonable to study the perceptions and data outcomes of subject specific virtual instruction on students with special education needs. Stakeholders deserve to know whether math scores improve more in a virtual setting than they did in a brick and mortar school setting. The ensuing chapters will describe the procedures used to collect the data and the students' perceptions regarding online math instruction, and analyze the information that can be used to guide instruction and attain purposeful learning outcomes.

CHAPTER III

METHODS

The purpose of this study was to analyze the effectiveness of online mathematics instruction for high school students with special education needs attending the virtual school. The interview research focuses on the areas of student perceptions about skills and progress, student work habits and patterns of study, comparisons with face-to-face instruction, and understanding what works for students with disabilities. The purpose of this chapter is to describe the procedure, the sample, interview instrument, data collection, design of research, and analysis of data.

Procedures

Setting. This study was conducted in a tuition-free, public, virtual, charter school in mid-sized school district located in a Midwestern town of 7,800 people. Students who attend the virtual school can live anywhere in the state and attend through open enrollment procedures. The virtual school has been in existence for four school years and enrolled 1,964 kindergarten through twelfth grade students during the 2012-2013 school year. This is up from 1,058 students the previous school year. According to the state database, the student body racial/ethnic makeup of the school is 78% White, 7.5% Black, 7.3% Hispanic, 1.6% American Indian, 1.6% Asian, while 3.6% identified themselves as two or more races or ethnicities. 12.5% of students enrolled during the 2012-2013 school year were identified as economically disadvantaged, while 87.5% were either not

economically disadvantaged or no data was reported. English proficiency was reported to be 98.9%, while 14.1% of the study body was identified as having a disability. Of the 14.1% of students with disabilities, 3.4% had Specific Learning Disabilities (SLD) as their primary disability, 2.8% had Emotional Behavioral Disabilities (EBD), 2.4% had Speech or Language Impairments (SL), 0.7% had Cognitive Disabilities (CD), and 4.7% had other primary Disabilities (Wisconsin Department of Public Instruction, 2013).

Sample description. All participants for this study were students enrolled in the virtual school in grades nine through twelve. The participants were previously identified as having special education needs. A letter of consent was sent to 30 students and their parents or guardians. Thirteen consent forms were returned for a response rate of 43.3%. Of the thirteen respondents, nine agreed to be a part of the entire study including the interview, one agreed to be a part of the study but refused to be interviewed, and three students replied that they did not wish to be a part of the study. Of the nine students who agreed to be part of the entire study, five students actually made themselves available to participate in the interview portion. The participants of the study consisted of the following grade levels: 30% ninth grade, 40% tenth grade, 10% eleventh grade, and 20% twelfth grade. The gender of the sample was evenly split, 50% of student participants were male and 50% were female. The participants' disabilities were distributed in the following manner: 40% Specific Learning Disability (SLD), 10% Cognitive Disability (CD), 20% Emotional Behavioral Disability (EBD), 20% Autism (A), and 10% Other Health Impairment (OHI) and SLD. All ten student participants lived in different areas of the state.

Data collection procedures. Approval from the Institutional Review Board (IRB) was received prior to initiating the study (See Appendix A for letter of approval). Permission from the Head of School, on behalf of the school board, to recruit student participants was also obtained before the study began. The participants for this study were selected through purposive sampling. Thirty students and their parents or guardians from the researcher's student caseload received an informational letter and consent form (See Appendix B for a copy of the letter and consent form).

Data collection consisted of interviews with each participant and a review of academic records. The qualitative interviews permitted the researcher to study how people interpret their own experiences and share them in their own words. The interviews were conducted over the telephone and lasted up to 30 minutes. The following information and instructions were read to the participants prior to completing the interview:

"Thank you for agreeing to participate in this study. As part of this study, I will be conducting a review of your academic records. These records could include, but are not limited to, the following items: student cumulative files, Scantron Performance Series Assessment scores, standardized state test scores, and grades. Please answer the following questions honestly and to the best of your ability. Your identity and answers will remain confidential and your participation will have no effect upon any grade in any course at the virtual school."

Fifteen open-ended interview questions allowed for structure but also logical follow-up questioning (See Appendix C for a copy of the interview questions). The interview questions were developed through a process of idea generating. The researcher wanted to know the students' level of satisfaction with online math classes, as well as the

students' abilities and opinions with regards to the subject of math in general. Another important consideration was the students' levels of school engagement and experience with online schooling. The students were asked to compare their math experience online to their experiences in brick and mortar schools. This question was intended to help determine whether changes in math processes, perceptions, or opinions could be attributed to virtual learning. The five math teachers at the virtual school reviewed the questions to determine their validity and deemed the questions to be valid and reliable insofar as student responses are honest and consistent over time. The teachers agreed that the questions asked were relevant to obtaining a better understanding of students' processes, perceptions, and opinions with regards to taking math classes in an online format. The students were asked questions about their perceived level of math skills, which math course they were currently enrolled in, tools they used in math class, student level of comfort and experience with online learning and online math courses, and comparison questions with math and other courses in the face-to-face and online environment. The questions were open-ended, allowing for free responses from students. In addition, the responses to the questions were used to determine the students' levels of self-efficacy with regards to mathematics and compared with their actual performance in mathematics. Student responses were recorded verbatim by the researcher.

Student records, including math course grades from brick and mortar and virtual schools, the most recent standardized state test scores, and Scantron Performance Series Assessment scores from the 2012-2013 were analyzed to determine approximate student abilities and grade level equivalents in math. See Appendix D for an interpretation of the

standardized state test performance levels and Appendix E for Placement Indicators of Scantron Performance Series Assessment.

Research Design

The research conducted is a mixed-method study that included a review of existing student data and an interview with student participants. This design was employed to collect and compare the quantitative data from the review of records and the qualitative detail obtained from the student interviews. The quantitative data that was collected includes math courses attempted in the brick and mortar and virtual schools, grades in those courses, state standardized test results, and Scantron Performance Series Assessment. The focus of the interviews was math processes and perceptions of math efficacy for students with disabilities. The researcher wanted to know about their perceived skills in the subject of math and their perceived progress in online mathematics courses compared to other subject areas and other online courses, as compared to similar math experiences in the brick and mortar learning environment. The qualitative data was collected and analyzed to determine recurrent themes and best practices for students with disabilities enrolled in math courses, and possibly beyond the scope of math classes. The quantitative and qualitative data were analyzed for correlation between academic performance in math and perceptions of efficacy.

Data Analysis

The existing student data that was utilized were typical indicators used to document students' present levels of academic performance for students with disabilities in an Individual Education Plan (IEP). These indicators were deemed to be relevant for this study by the math teachers consulted and by the primary researcher, a special education teacher at the virtual school. Student grades in math courses were retrieved from the end-of-year transcript. The courses and grades were listed in the data table for each student under the heading where the student took the course, Brick and Mortar or Virtual School. Changes in grade patterns were noted from the courses completed in the brick and mortar school versus the virtual school. Standardized state test results, when available, provided a reference for baseline math skills of students. Finally, Scantron Performance Series Assessment results from fall of 2012 and spring of 2013 were listed in the students' data tables. The scores were cross-referenced against the Scantron Performance Series Indicator Chart to determine an approximate grade-level functional equivalency. Changes in scores from the first attempt to the second attempt were noted for improvement or regression.

Student interview consisted of open-ended questions used to determine themes among student processes, experiences, and perceptions in regards to math being taught in the virtual school, versus the brick and mortar environment. Student responses were determined to indicate either high level efficacy or low level efficacy based on the positive or negative connotation of students' experiences and opinions expressed in the free-response information they provided to the interviewer. Two interviews were coded

by both the researcher and another virtual math teacher to determine the reliability of the scoring. They coded responses with 94% agreement. The items that were coded differently were discussed until they came to an agreement. This insured greater degree reliability in the coding of the qualitative data. This information was paired with the quantitative data to develop a narrative of each student's experiences and functioning with math skills.

Summary

This mixed- method study utilized a qualitative interview methodology to study perceptions of students with disabilities regarding their math skills, progress in online math courses, and opinions of math classes taught in the virtual environment, paired with a qualitative analysis of academic records. The data collected during student interviews and by review of academic records helped to better understand the effects that receiving math instruction in the virtual school environment had on high school students with disabilities. The results of this data collection and analysis will be the focus of Chapter Four Results. Chapter Five contains discussion of the observed effects of online math instruction for high school students with disabilities and implications for future practice and research.

CHAPTER IV

RESULTS

The researcher both designed and implemented a methodical review of existing student data, including review of transcripts and grades from the brick and mortar school, if applicable, and the virtual school, standardized state test results, and the district administered Scantron Performance Series assessment results. The researcher also conducted an interview over the telephone. Students were asked questions regarding their personal opinions, experiences, and perceptions in terms of math classes taken in the virtual environment, as compared to their opinions, experiences, and perceptions of math taken in the brick and mortar. Following are the findings for each student.

Student One

Student One was a twelfth grade female student with OHI and SLD. She attended her first year in a virtual school setting during the 2012-2013 school year. She came to the virtual school having attempted *Math I* and *Algebra I* in her brick and mortar school. Although she passed both semesters of Math I, she did not pass either semester of *Algebra I*. Student One attempted two semesters of *Math Foundations I* and one semester of *Pre-Algebra* at the virtual school. She passed the first semester of *Math Foundations I* with a grade of C, but failed the second semester of *Math Foundations I* and *Pre-Algebra*. Student One was considered to be a student at risk by the virtual school due to her inconsistent engagement in her courses. She passed four of the ten

courses she attempted during the course of the school year but failed to earn the required number of credits to graduate with her cohort class. Standardized state test scores from her tenth grade year indicated that Student One was functioning at the Minimal Performance level in mathematics. Student One did not attempt the assessment during the testing windows in spring 2013, therefore growth over the course of the school year could not be measured. Although she agreed to fully participate in the study, Student One did not avail herself for the interview portion of the study, despite numerous attempts to involve her.

Table 1. Summary of Student One's Grades, State Test Scores, and Scantron Scores

Brick & Mortar		Virtual School		Math Scantron		
Math Classes Attempted	Math Class Grades	Math Classes Attempted	Math Class Grades	Recent States Test Results	Fall 2012	Spring 2013
Math I	C-	Math Foundations I	C	Minimal Performance	2359	-
Math I	P	Pre-Algebra	F			
Algebra I	F	Math Foundations I	F			
Algebra I	F					
Algebra I	F					

Student Two

Student Two was a female tenth grade student in her first year of attending school in the virtual setting. Student Two was a student with CD and came to the virtual school having attempted two semesters each of *Consumer Math* and *Algebra* in her brick and mortar school. Although she passed both semesters of *Consumer Math* with a grade

of *B*, she failed both semesters of *Algebra*. Student Two attempted and passed both semesters of *Math Foundations I* with grades of *B-* and *B+*, respectively. Student Two passed all nine of the courses she attempted during the school year at the virtual school. Standardized state test scores indicated that Student Two was functioning at the Minimal Performance level in mathematics. Scantron Performance Series Assessment scores from fall 2012 indicate that Student Two was functioning at approximately at the late second grade level. Her assessment score in spring 2013 indicated that she was functioning at the early sixth grade level, with an improvement of more than three grade levels. Despite her agreement to fully participate in the study, Student Two did not avail herself to the interview portion of the study.

Table 2. Summary of Student Two's Grades, State Test Scores, and Scantron Scores

Brick & Mortar		Virtual School			Math Scantron	
Math Classes Attempted	Math Class Grades	Math Classes Attempted	Math Class Grades	Recent States Test Results	Fall 2012	Spring 2013
Consumer Math	B+	Math Foundations I	B-	Minimal Performance	2210	2489
Algebra	F	Math Foundations I	B+			
Consumer Math	B					
Algebra	F					
Algebra	F					

Student Three

Student Three was a male tenth grader with EBD. Student Three came to the virtual school having attempted and passed one semester of *Mathematics 9* with a grade

of *D*. At the virtual school, Student Three attempted two semesters of *Math Foundations I* with grades of *C+* and *B*, respectively. Student Three passed all nine of the courses that he attempted at the virtual school during the school year. Although standardized state test scores is a school-wide requirement, Student Three did not take the state assessment this school year. Scantron Performance Series Assessment scores from fall 2012 for math indicate that Student Three was performing at the fifth grade level. Although his Scantron score did not increase a grade level in spring 2013, his score improved 33 points from fall 2012 to spring 2013. Student Three was interviewed over the telephone to discuss his perceptions about his math abilities and opinions about the virtual school math courses he was taking. He indicated that he felt math was his strongest subject in school. He regularly attended scheduled synchronous math classes with his teacher and reported spending 1-1.5 hours per day on math. He reported that he felt algebra was the most challenging part of math for him. When asked how taking math online affects that challenge he replied, "It's better working with teachers. They answer your question faster than in my other school." He indicated that he felt taking math online was easier than in the brick and mortar environment and stated, "You get to ask more questions and can go ahead faster." Student Three reported that he did not print out his math homework; he worked problems on the computer directly, and he regularly used a calculator and multiplication chart to complete his work. Student Three indicated that he felt his math skills have improved in the virtual learning environment. He stated, "I can do harder math than in my regular school." He indicated that would recommend taking math in the virtual environment to others because, he stated, "It's better this way."

Table 3. Summary of Student Three's Grades, State Test Scores, and Scantron Scores

Brick & Mortar		Virtual School			Math Scantron	
Math Classes Attempted	Math Class Grades	Math Classes Attempted	Math Class Grades	Recent States Test Results	Fall 2012	Spring 2013
Mathematics 9	D	Math Foundations I	C+	-	2375	2408
		Math Foundations I	B			

Student Four

Student Four was a male eleventh grader with EBD. He came to the virtual school during the second semester of the school year, having attempted in the brick and mortar one semester of *School Service Math* with a grade *S* (Sufficient Progress), two semesters of *Algebra I* with grades of *C-* and *D-* respectively, one semester of *Geometry* with a grade of *F*, one semester of *Independent Math III* with a grade of *D-*, and one semester of *Personal Finance I* with a grade of *F*. At the virtual school, Student Four attempted two semesters of *Math Foundations I* with a grade of *A* for both courses. Student Four passed all nine courses that he attempted during the course of the school year. Standardized state test scores from his tenth grade year indicated that Student Four was functioning at the Basic level in math. Due to second semester enrollment at the virtual school, Student Four did not take the Scantron Performance Series Assessment in fall 2012. His score in spring 2013 indicated that he was functioning at the tenth-eleventh grade level. Despite agreeing to fully participate in the study and numerous

attempts to contact him, Student Four did not respond to the researcher regarding the interview portion of the study.

Table 4. Summary of Student Four's Grades, State Test Scores, and Scantron Scores

Brick & Mortar		Virtual School		Math Scantron		
Math Classes Attempted	Math Class Grades	Math Classes Attempted	Math Class Grades	Recent States Test Results	Fall 2012	Spring 2013
Algebra I	C-	Math Foundations I	A	Basic	-	3088
Algebra I	D-	Math Foundations I	A			
Geometry	F					
Independent Math II	F					
Independent Math II	D-					
Personal Finance I	F					

Student Five

Student Five was a ninth grade male student with autism. Student Five came to the virtual school with no previous virtual learning experience. He attempted two semesters of *Math Foundations I*, both with a grade of *A*, and one semester of *Pre-Algebra* with a grade of *C*. Student Five passed all ten courses that he attempted at the virtual school during the school year. Student Five was not in a grade in which standardized state assessment was administered and no previous scores or performances were indicated in his student records. Scantron Performance Series Assessment scores from fall 2012 indicated that Student Five was functioning at the 10th grade level in math;

however, while scores from spring 2013 continued to indicate he was functioning at the tenth grade level, some regression may have occurred, as his score dropped 70 points from fall 2012 to spring 2013. Although Student Five agreed to participate in the review of records portion of the study, he declined to be interviewed for the study.

Table 5. Summary of Student Five's Grades, State Test Scores, and Scantron Scores

Brick & Mortar		Virtual School			Math Scantron	
Math Classes Attempted	Math Class Grades	Math Classes Attempted	Math Class Grades	Recent States Test Results	Fall 2012	Spring 2013
-	-	Math Foundations I	A	No Information in Table File	2899	2829
		Math Foundations I	A			
		Pre-Algebra	C			

Student Six

Student Six was a female tenth grade student with SLD. She came to the virtual school having attempted two semesters of *Math* with grades of *B* and *B-* respectively in the brick and mortar school. At the virtual school, Student Six attempted two semesters of *Pre-Algebra* with grades of *D+* and *B-* respectively. Standardized state test results indicated that Student Six was performing at the Basic level in math. Scantron Performance Series Assessment scores from fall 2012 indicated that Student Six was functioning at the early tenth grade level in math. Her score from spring 2013 improved by 145 points and indicated that she was functioning at the mid-tenth grade level.

Student Six was interviewed by telephone to discuss her perceptions about her math abilities and opinions about the virtual school math courses she was taking. Student Six attended scheduled synchronous classes with her teacher approximately one out of four opportunities and indicated she spends approximately 30 minutes daily on math work. When asked if she considered her abilities in math to be an area of strength or weakness, she reported, “In the middle,” and that “shapes, area, and formulas” were areas that were most challenging to her. She repeated, “In the middle,” when asked how the virtual environment had impacted the challenges she faced with shapes, area, and formulas. Student Six indicated that she although she found math to be easier in the virtual environment, she did not feel that online instruction was different from face-to-face math instruction in the brick and mortar environment. Student Six reported that she printed her math homework and completed much of it with paper and pencil, rather than directly on the computer. She also reported regularly using a calculator to complete her course work. Student Six attributed an improvement in her math skills due to, “Teachers [being] more involved in helping me.” She indicated that she would recommend taking math online to other students because she stated, “They [teachers] are more interested in how you are doing and take extra time to help you.”

Table 6. Summary of Student Six’s Grades, State Test Scores, and Scantron Scores

Brick & Mortar		Virtual School			Math Scantron	
Math Classes Attempted	Math Class Grades	Math Classes Attempted	Math Class Grades	Recent States Test Results	Fall 2012	Spring 2013
Math	B	Pre-Algebra	D+	Basic	2631	2776
Math	B-	Pre-Algebra	B-			

Student Seven

Student Seven was a male ninth grade student with autism. Student Seven had no previous virtual school experience. He attempted two semesters of *Math Foundations I* and earned the grade of A for both semesters. He passed all nine courses that he attempted at the virtual school during the school year. Student Seven was not in a grade in which standardized state assessment was administered and school records do not indicate results from previous attempts. Scantron Performance Series Assessment scores from fall 2012 indicated that Student Seven was functioning at the early sixth grade range in math. Assessment results from spring 2013 indicate an increase of 236 points and that Student Seven was functioning at the early ninth grade level in math. Student Seven was interviewed over the telephone, with the assistance of his mother. He attends all scheduled synchronous classes with his teacher and indicated that he spends approximately an hour per day on math work. He reported that he must work out problems with pencil and paper, rather than directly on the computer, and he regularly uses a calculator to complete his work. Student Seven reported that he felt math was an area of weakness for him and algebra was particularly challenging for him. He indicated that learning math in the virtual environment eased many of his challenges. He stated, “I’m not distracted by other kids,” and indicated that materials being presented in smaller chunks, seeing immediate results and success, and reinforcement of skills through repetition were also helpful to him. Student Seven indicated that he believed that not only have his math skills improved, but also his motivation, his ability to recognize the

importance of materials, and his ability to work independently. He reported that he would recommend taking math in the virtual environment, “if you get help from your mom or dad.”

Table 7. Summary of Student Seven’s Grades, State Test Scores, and Scantron Scores

Brick & Mortar		Virtual School			Math Scantron	
Math Classes Attempted	Math Class Grades	Math Classes Attempted	Math Class Grades	Recent States Test Results	Fall 2012	Spring 2013
-	-	Math Foundations I	A	No Information in Table File	2470	2706
		Math Foundations I	A			

Student Eight

Student Eight was a twelfth grade female student with SLD. Student # 8 came to the virtual school having attempted two semesters of *Applied Algebra I* with a grades of *D* and *D-* respectively, and two semesters of *Applied Algebra II* with grades of *C-* and *D-* respectively. In her first year of experience in a virtual environment, Student Eight completed the equivalent of 2 semesters of *Pre-Algebra* with a grade of *P* (Pass), two semesters of *Consumer Math* with grades of *D* and *F* respectively, and one semester of *Math I* with a grade of *P*. Of the fifteen courses Student Eight attempted during the course of the school year, she earned passing grades in fourteen of them. Standardized state test scores from her tenth grade year indicate that Student Eight was functioning at the Minimal Performance level in math. Student Eight completed the Scantron Performance Series Assessment in fall 2012, with scores indicating that she was

functioning beyond the tenth grade level in math. She did not complete the assessment in spring 2013. Student Eight was interviewed over the telephone. She did not regularly attend scheduled synchronous classes with her teacher and reported that she typically spends about three hours one time per week on math homework. She reported that she regularly used a calculator for math problems and prints out the work to complete with paper and pencil. Student Eight indicated that math was an area of weakness for her and division and algebra were areas of particular challenge for her. She mentioned, “Anything above 8th grade math, I’m totally stupid.” She stated that the online learning environment has improved her challenges in math because, “I have no distractions, but I still feel stupid cuz [*sic*] I don’t get the right answers and need help from my family.” She conveyed that she felt math in the virtual environment was easier and different from the face-to-face environment due to the one-to-one attention she receives from her teachers. She felt that she could get the help she needs and reported that she will not do the work if she cannot get just-in-time help. Student Eight did not believe that her math skills had improved in the virtual learning environment. She stated, “Math is where I have ADHD, it doesn’t click in my brain.” She indicated that she would recommend taking math online to some students, stating, “It’s easier if you can do it by yourself,” but would not recommend it to students who cannot learn math independently.

Table 8. Summary of Student Eight's Grades, State Test Scores, and Scantron Scores

Brick & Mortar		Virtual School		Math Scantron		
Math Classes Attempted	Math Class Grades	Math Classes Attempted	Math Class Grades	Recent States Test Results	Fall 2012	Spring 2013
Applied Algebra I	D	Pre-Algebra	P	Minimal Performance	3193	-
Applied Algebra I	D-	Consumer Math	D			
Applied Algebra II	C-	Consumer Math	F			
Applied Algebra II	D-	Math I	P			

Student Nine

Student Nine was a tenth grade female student with SLD. She came to the virtual school having completed two semesters of *Pre-Algebra* with grades of *C* and *B* respectively. In her first year of virtual learning at the virtual school, Student Nine completed two semesters of *Algebra I* with grades of *B+* and *A* respectively. She has successfully completed all eight courses that she has attempted during the school year. Standardized state test scores indicated that she was functioning at the Basic level in math. Scantron Performance Series Assessment scores from fall 2012 indicated that Student Nine was functioning at the early sixth grade level in math. Her scores from spring 2013 increased 401 points and indicated that she was performing at the tenth-eleventh grade level in math. Student Nine was interviewed over the telephone. She regularly attended scheduled synchronous classes with her teacher and indicated that she

often reviews the class recordings and seeks out her teacher several times per week for assistance. She reported that she spends thirty to sixty minutes per day on math, regularly uses a calculator and multiplication chart to complete her work, and prints her work to complete with paper and pencil rather than directly on the computer. When asked about her perceived level of math abilities in comparison to others, Student Nine replied, “It’s my top subject. My math skills have skyrocketed.” She indicated that dividing and multiplying fractions and decimals pose the biggest challenge for her. She found math in the online learning environment to be easier for her because, “I get [more] immediate attention than in my other school. They don’t always answer my questions. Teachers [in the virtual school] take more time with students.” The biggest difference Student Nine indicated between the virtual school and face-to-face math instruction was the immediate feedback she received from the computer-scored math problems. She also stated, “Teachers take the time to explain concepts and I understand better.” Student Nine indicated that she would recommend taking online math to other students because the teachers take time with the students, but reported that schooling from home does get lonely for her at times.

Table 9. Summary of Student Nine’s Grades, State Test Scores, and Scantron Scores

Brick & Mortar		Virtual School			Math Scantron	
Math Classes Attempted	Math Class Grades	Math Classes Attempted	Math Class Grades	Recent States Test Results	Fall 2012	Spring 2013
Pre- Algebra	C	Algebra I	B+	Basic	2497	2898
Pre- Algebra	B	Algebra I	A			

Student Ten

Student Ten was a ninth grade male student with SLD. He entered his first year at the virtual school with no other virtual learning experience. He attempted one semester of *Math 3* at the virtual school, but did not successfully complete the class. Student Ten was considered a student at-risk, as he did not pass any of the five courses that he attempted during the school year. Student Ten was not in a grade in which the standardized state assessment was administered and no previous assessment scores were indicated in his school records. Although Scantron Performance Series Assessment scores from fall 2012 to spring 2013 improved 87 points, he continues to function at the early ninth grade level in math. Despite agreement to participate fully in the study and numerous attempts to contact Student #10, he did not make himself available for interview.

Table 10. Summary of Student Ten's Grades, State Test Scores, and Scantron Scores

Brick & Mortar		Virtual School		Math Scantron		
Math Classes Attempted	Math Class Grades	Math Classes Attempted	Math Class Grades	Recent States Test Results	Fall 2012	Spring 2013
-	-	Math 3	F	No Information in Student File	2600	2687

Summary of Findings

Despite the relatively small sample size, much can be concluded from this study, as several themes emerged from the student interviews. In terms of letter grades in math courses, five of the ten student participants experienced an increase in grades, three

earned similar passing grades, while two students experience no improvement in their failing math grades. Four of the ten students had no results from state assessments, three students scored in the Minimal level, and three students scored in the Basic level. No students scored in the Proficient or Advanced levels. One of the ten students did not complete the Scantron Performance Series Assessment during either test window in fall 2012 or spring 2013, therefore no results were available. One student completed only the assessment given in fall 2012 and one student completed only the assessment given in spring 2013. Seven students completed the Scantron Performance Series Assessment in both fall 2012 and spring 2013. Of those seven students, six students experienced an increase in their overall math score, while only one student experienced a decrease in his math score.

CHAPTER V

DISCUSSION

What Are the Effects of Online Math Instruction?

This study set out to determine whether students' math scores improved more in the virtual setting than they did in a brick and mortar learning environment. After completing a review of the existing data and conducting interviews with the students, it can be said that the effects math instruction observed in the virtual learning environment are the same effects that might be found in students receiving instruction in the brick and mortar. However, several students in this virtual school did report increased levels of confidence and efficacy in their skills and motivation to complete their work. Perhaps more importantly, five of the ten students' math grades improved in the virtual school. Those students performed better in their online math courses compared to their grades in the brick and mortar school, and those who did not perform better did not perform worse in their math courses, however one student's Scantron score did decrease by 70 points. It is important to note that the two students who experience very limited success in any subject, including math, in the brick and mortar school also experienced very limited success in the virtual school environment.

One significant finding of the interview portion of the study was the level of confidence in math skills and increased motivation that students experienced in the virtual learning environment. Three of the five interviewed student participants indicated perceived improved math skills, one student indicated improved motivation to do math,

and one student indicated no improvement of math skills. This was the case regardless of the students' actual progress and present levels of ability in math, assessment scores, and grades in math classes. Another common theme among interview participants was the ability to get the necessary just-in-time help from teachers they needed to be able to do their work. Four of five interviewed students indicated that they experienced a greater amount of attention and help from teachers in the virtual learning environment, when compared to face-to-face instruction. Additionally, three students reported they experienced increased motivation from immediate feedback on auto-graded assignments, and three students indicated a decrease in distractions as contributing to their perceived success in virtual math learning. Students did not report differences in their perceptions about the effectiveness of online math instruction compared to face-to-face instruction. They attributed their levels of confidence and success to the improved access to and relationships with the teachers.

Comparison of Findings

The findings of this study tend to support the findings of other studies completed on virtual schooling; virtual schools can be as effective in math instruction as brick and mortar schools are. In this study, however, the findings indicated that eight of the ten participants maintained or demonstrated improvement from the brick and mortar school to the virtual school, in terms of math grades, and six of the seven participants demonstrated an improvement in their Scantron assessment. Perhaps just as significant were the levels of self-efficacy indicated by the students that were interviewed. Four out

of the five students that were interviewed indicated a heightened sense of confidence in their math abilities. Their confidence levels in math were paired with marked improvements in grades and test results. Although one of those interviewed indicated a low level of self-efficacy, her grades remained similar to previous efforts in math classes in the brick and mortar learning environment. She had only one Scantron score to reference, so growth over the course of the school year was not able to be measured. Despite not seeing many positives in her own abilities, she indicated an overall positive experience with online math instruction. These findings also support the position self-efficacy in Albert Bandura's social cognitive theory. In this study, students with a relatively high sense of self-efficacy made gains in grades and test scores. The one student without a high level of self-efficacy made no improvements to her grades.

Five of the students were not able to be interviewed to compare their levels of self-efficacy to their grades and test scores. Of the five students who were not able to be interviewed, two experienced improved grades, one experienced similar grades, and two had no previous high school math classes or grades indicated on their transcripts. Of those same five students who were not interviewed, two students improved their Scantron performance, one student's score decreased, and two students had only one score to reference and therefore growth was not able to be measured.

Professional Opinion

It is the opinion of the researcher that a student's level of self-efficacy is an integral factor in determining that student's level of school success, not only in

mathematics, but likely in all subject areas, as Bandura found that people with high levels of self-efficacy typically demonstrated that in many aspects of their lives. The students in this study who demonstrated high levels of self-efficacy likely entered the virtual school with a similar level, since it is not typically something that is quickly or easily changed (Bandura, 1977). In addition, people are more likely to improve their self-efficacy if success can be attributed to ability, rather than from peripheral elements or luck. Students must experience success and attribute it to personal abilities to improve their level of efficacy. Unfortunately, “people...because of faulty appraisals of the circumstances under which they improve, will credit their achievement to external factors rather than to their own capabilities (Bandura, 1977, p. 201).

High levels of self-efficacy may also be an indicator of a student’s academic abilities in a subject area. It may be possible, however unlikely, that a student with a high level of academic self-efficacy has an equally low level of academic ability. It is not certain which comes first, the ability or the efficacy. Either way, it is clear that when a student feels that he or she can be successful at a given task, that student is less likely to give up in the face of adversity, more likely to follow through to solutions, and more likely to do well in school. For teachers accountable to the Common Core State Standards, this is an especially important connection, since these standards also emphasize processes and proficiencies that include a level of belief in one’s own abilities.

Strengths and Limitations

The nature of qualitative studies provides us with a look at data that cannot easily be described with numbers. It can communicate information and detail about people's experiences, perceptions, and opinions that does not easily fit into predictable responses. A primary strength of this particular study is that it contains qualitative data. The research includes information reported directly by the student participants about their personal experiences, opinions, and self-perceptions. This type of information may not be reported precisely through rating scales or data tables. In addition, this research study follows the grades and progress of the participants over the course of an entire school year, which is an adequate timeframe to measure growth, since it could be expected that students will make a minimum of one year's progress in that time.

The known limitations of the study include the fact that all participants were attending a virtual school, and thereby making a comparison with students in a brick and mortar school impossible. All students in the study were students with special education needs, which may include a disproportionate number of students with skill deficits in math. The study also included students who were disengaged in their math courses and/or those who were not attending their virtual math classes with consistency or regularity, making a study of their scores less relevant than students who were relatively more engaged in their math classes. In addition, all students mentioned in this study were willing to participate. Their skills and opinions may not be representative of an overall sample. The relatively small sample size is a limitation of this study, however, the participants can be considered to be a representative sample of the larger population of

high school students with disabilities. Furthermore, only five of the ten participants were interviewed for their thoughts and opinions, four of the ten participants had standardized state assessment scores available, and three of the ten participants did not complete one or more of the Scantron assessment opportunities. There is missing data for several of the participants. Although the interview participants appeared candid with their responses, they were interviewed by their teacher, so it is possible that they were not entirely honest with their answers. Additionally, this study relied upon grades and statewide or district-wide assessments to determine the effects of online math instruction. It is possible that these criteria may not be complete or accurate indicators of the students' skill levels in math. The study was limited to the analysis of existing data. There may be a correlation of data, but the causes of the variables are not revealed through the study. The research conducted was limited to high school students with special education needs in one virtual school, in which math was the primary focus. These limiting factors hinder the ability to generalize findings across subject areas, student populations, or to other school settings.

Implications for Practitioners

The researcher uncovered several results that could be used to guide learning and instruction for both students and teachers.

Recommendations for students. Students who regularly attended synchronous sessions with their teachers reported that they felt supported in their math classes and had greater access to teachers to receive the just-in-time help they felt they needed. In cases

where students are not regularly attending live classes, they are encouraged to do so. It is also recommended that students use tools such as calculators and multiplication charts to assist with math calculations, but also work to improve their math skills to a level of automaticity with single and double digit calculations. In addition, printing math work and working problems with paper and pencil is encouraged.

Recommendations for teachers and the virtual school. Students who were interviewed indicated a closeness they felt to their teachers and a sense that the teachers were accessible and truly cared about their well-being. It is highly recommended that virtual schools maintain a low teacher to student ratio to ensure this level of care and involvement from the teachers. Virtual schools should continue to hire only highly qualified teachers who are experts in their fields, and virtual school teachers should continue to pursue opportunities for professional growth to hone their skills as effective educators. It is also recommended that teachers follow up with students who do not regularly attend synchronous class sessions and encourage their attendance.

Implications for Future Research

Due to the tremendous growth of virtual education, future research should focus on the evidence of effectiveness of online math instruction. Virtual schools have grown exponentially as private and public school options, and it is imperative that they are held to the same standards of evidence-based instruction as brick and mortar schools are held. Future research in this area could focus on the actual instructional methods being employed to teach in the virtual classroom. Another interesting perspective the research

might take could be to attempt to measure the levels of self-efficacy attributable to the virtual learning environment.

Summary

This thesis project required the gathering and analysis of data used to identify perceptions of skills and progress, and the trends of ten high school students with disabilities taking online mathematics courses at the virtual school. It also compared perceptions about instruction in the virtual learning environment with that in the traditional face-to-face learning environment. The information will assist mathematics and special education teachers in improving their instruction and the student experience in the online school.

APPENDIX A

Institutional Review Board Approval



1/10/2013

Dear Ms. Maga-Daniels:

On behalf of the UW Oshkosh Institutional Review Board for Protection of Human Participants (IRB), I am pleased to inform you that your application has been approved for the following research: Effects of Online Mathematics Instruction. The approval is valid for one year from the date of this letter.

Your research has been categorized as NON-EXEMPT, which means it is subject to compliance with federal regulations and University policy regarding the use of human participants as described in the IRB application material. Your protocol is approved for a period of 12 months from the date of this letter. A new application must be submitted to continue this research beyond the period of approval. In addition, you must retain all records relating to this research for at least three years after the project's completion.

Please note that it is the principal investigator's responsibility to promptly report to the IRB Committee any desired changes in the research project, whether these changes occur prior to undertaking, or during the research. In addition, if harm or discomfort to anyone becomes apparent during the research, the principal investigator must contact the IRB Committee Chairperson. Harm or discomfort includes, but is not limited to, adverse reactions to psychology experiments, biologics, radioisotopes, labeled drugs, or to medical or other devices used. Please contact me if you have any questions (PH# 920/424-2328 or e-mail: mirona@uwosh.edu).

Prior to the end date of the approval period, please return a summary report "IRB Status Form" to the Office of Grants and Faculty Development. The form may be found electronically at: <http://www.uwosh.edu/grants/forms/grants-forms/IRB-Status-Form-2012-09-04.docx> and may be returned via e-mail to irb@uwosh.edu or to our office in Room 214 in Dempsey Hall.

Sincerely,

Dr. Anca Miron
IRB Chair

Protocol Number 972328
cc: Dr. Thomas Fischer

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APPENDIX B

Informational Letter and Consent Form

CONSENT DOCUMENT

Jodi Daniels, Special Education Teacher at [REDACTED] (the virtual school) and Master's degree candidate at the University of Wisconsin Oshkosh, working under the advisement of Dr. Thomas Fischer, is conducting a study of the effects of online mathematics instruction for high school students with special education needs.

In this study that will be conducted over the course of the 2013 spring semester, approximately February through May, I will review student education records and collect data about student performance in his or her math courses. I would appreciate your participation, as it will assist me in when presenting my information to our Head of School as well as families and students of [REDACTED] (the virtual school) in the future.

In addition to a review of student records, I would like to conduct interviews with students enrolled in math classes at the virtual school. I will be conducting the interviews that should take approximately 20 minutes. Interviews will be conducted over the telephone, or when convenient for the participant, through Blackboard Collaborate online conferencing tool.

More information is needed on the effects of mathematics instruction in the virtual school environment for students with special education needs. Speaking to students and families and gauging their perspectives will contribute to the current body of work on this topic.

We do not anticipate that the study will present any risk to you, other than the inconvenience of extra time to complete the interviews. The information that I gather through our interviews will be recorded on a confidential form for my use only. We will not release information about you or your family in a way that can identify you.

Participation in this study is completely voluntary and will have no bearing on student grades, services received, or any other educational decision made for or on behalf of the student. If you choose to withdraw from this study at any time, you may do so without penalty. The information collected from you and your family will be destroyed.

Once the study is completed, I would be glad to give the results to you. In the meantime, if you have any questions or concerns, please feel free to contact my advisor:

Dr. Thomas Fischer, Department of Special Education
UW-Oshkosh Oshkosh, WI 54901
920-424-7237 fischert@uwosh.edu

If you have any complaints about your treatment as a participant in this study, please call or write:
Chairperson, Institutional Review Board For Protection of Human Participants c/o Grants Office
UW-Oshkosh Oshkosh, WI 54901
920-424-1415

Although the chair person may ask for your name, all complaints are kept confidential.

Sincerely,

Jodi Maga-Daniels

Please return this form by March 20, 2013, even if you choose not to participate. Thank you!

Student Name- Printed

Student Signature

Date

☐ I give my consent for the above student to participate in the interview and review of records. I have received an explanation of the study. I understand that participation in this study is strictly voluntary and will in no way affect the student's grades.

☐ I do **NOT** give my consent for the above student to participate in the interview and review of records. I have received an explanation of the study. I understand that participation in this study is strictly voluntary and non-participation will in no way affect the student's grades.

Parent Signature

Date

This research project has been approved by the University of Wisconsin Oshkosh IRB for Protection of Human Participants for a 1-year period.

APPENDIX C

Student Interview Questions

Student Name: _____**Date of Interview:** _____

- Which math class are you currently taking?
- How many years have you been taking math online?
- Do you regularly attend the synchronous *Class Connect* and/or study hall sessions with your math teacher? If yes, how often?
- In comparison with other subjects, where do you consider your abilities to be in math, an area of strength or weakness?
- In terms of math (just the subject area) what do you believe is the most challenging part of mathematics?
 - In terms of taking math online, how does taking math online affect that challenge?
 - Do you find math to be easier or more difficult to do online than in the traditional school environment?
- Do you feel that taking math online is any different than taking it in a face-to-face environment?
 - Why or why not?
 - How often to you work on it?
 - Do you print out work and complete with paper and pencil?
 - Do you use calculator or other math tools?
 - How much time on a daily/weekly basis to you put in on math work?
- How do you think your math skills have improved/changed since taking math online?
- Would you recommend taking math online to other students?
 - Why or why not?

APPENDIX D

Standardized State Assessment Performance Level Interpretations

Mathematics Scale Score by Grade

Performance Level	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 10
Advanced	492-630	526-650	553-680	573-700	591-710	605-730	618-750
Proficient	438-491	474-525	501-552	524-572	544-590	558-604	574-617
Basic	388-437	425-473	449-500	475-523	500-543	510-557	528-573
Minimal Performance	220-387	240-424	270-448	310-474	330-499	350-509	410-527

These new cut scores and performance level descriptors will serve as a bridge to the more rigorous Smarter Balanced assessments, which will be introduced in the 2014-15 school year. Smarter Balanced is developing assessments aligned to the Common Core State Standards in English language arts and mathematics—academic standards that are designed to help prepare all students to graduate from high school college and career ready.

Performance Levels:

- **Advanced** - Students at this level demonstrate a comprehensive and in-depth understanding of rigorous subject matter and provide sophisticated solutions to complex problems.
- **Proficient** - Students at this level demonstrate a solid understanding of challenging subject matter and solve a wide variety of problems.
- **Basic** – Students at this level demonstrate partial mastery of prerequisite knowledge and skills that are fundamental for proficient work.
- **Minimal Performance** – Students at this level demonstrate limited knowledge and skills in the subject matter and limited ability to apply knowledge and skills effectively.

APPENDIX E

Scantron Performance Series Placement Indicators



Scantron Performance Series Indicator Chart

The students Scantron Scaled Score will determine their indicator below:

Math Fall

Grade	At Risk	On Target	Advanced
2	Below 1892	1893-2250	2251+
3	Below 2115	2116-2420	2421+
4	Below 2265	2266-2543	2544+
5	Below 2357	2358-2679	2680+
6	Below 2463	2464-2838	2839+
7	Below 2529	2530-2918	2919+
8	Below 2593	2594-3013	3014+
9	Below 2608	2609-3095	3096+
10-12	Below 2613	2614-3180	3181+

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