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Did learning mathematics online increase students' math proficiency?: an outcome study of a vocational high school's use of an online mathematics program

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Did Learning Mathematics Online increase Students' Math Proficiency?:
An Outcome Study of a Vocational High School's use of an Online Mathematics
Program

A dissertation presented

By

Taimi H. Paadre

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ABSTRACT

This mixed methods outcomes study investigated a summer school mathematics program for all incoming 9th grade students at a suburban New England vocational technical high school. Qualitative data was gathered via survey and interview from administration, faculty, and students involved with the newly introduced online learning program. Additionally, each student was tested in the Spring and Fall of 2010 with the Northwest Evaluation Association (NWEA). These scores were analyzed to determine change in mathematics skills. Comparison of spring and fall NWEA scores of students who did not use the online math program and those who used it independently or as part of a hybrid class were not found to be statistically significant when an analysis of covariance (ANCOVA) test was administered.

Investigation of the 9th grade students end of the year math scores also revealed no statistically significant relationship between grades and participation in any of the three student groups - (1) students who did not use the online program; (2) students who used the online program independently; and (3) students who used the online program with support of an instructor in a hybrid summer math class.

Keywords: Online Learning, Hybrid Instruction, Mathematics, Vocational Technical High School

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Chapter 1: Introduction

The online learning phenomenon is becoming a regular part of K-12 education in the United States. According to a 2008 report released by the United States Department of Education (DOE) National Center for Education Statistics “In 2004-05 there were an estimated 506,950 technology-based distance education course enrollments in public school districts” (Zanberg & Lewis, 2008, p. iv). While the programs are proliferating, current controlled research regarding the effectiveness of online learning is lacking.

According to Picciano & Seaman (2007), there is limited data available regarding the number of students participating in online learning or distance learning programs (p. 12). They further point out the problem exists because there is limited data being collected by the states as to numbers of students participating; there is also confusion regarding the definitions of online learning and distance education; and finally there is significant growth outside the traditional school structures (Picciano & Seaman, 2007, p. 12). The online learning phenomenon is becoming a regular part of K-12 education in the United States, however many questions remain. While the programs are proliferating, current controlled research is lacking. This study will be one effort to look at how a vocational technical high school redesigned its summer school math program to include online learning as a component of instruction and the impact it may have had on students’ math skills as measured by a pre- and post-testing with a standardized, norm-referenced assessment.

Online learning opportunities are becoming more popular as schools embrace new technologies and apply them to the classroom setting. However, caution is warranted due to the current lack of research comparing the two approaches to instruction and their respective effectiveness. According to a meta-analysis conducted in 2009 for the U.S. Department of

Education Report by Means, Toyama, Murphy, Bakia, & Jones, (2009) comparing online learning versus face-to-face instruction, only five controlled studies were found in the K-12 educational arena. The report concludes that “educators making decisions about online learning need rigorous research examining the effectiveness of online learning for different types of students and subject matter as well as studies of the relative effectiveness of different online learning practices” (p. 54).

Current data regarding the impact of online learning is also limited in that it lacks qualitative information to help identify potential challenges, barriers and successes of online learning programs despite the high number of programs currently offered.

According to Bernhardt (2009), “we often try to change schools from where we think they are, instead of from where they actually are” (p. 16). This study will provide data on one online learning program and how it impacted the faculty and students at one New England vocational technical high school. It further provides information on the challenges this school faced while also investigating changes in assessment data of student math skills. Additionally, end of the year math grades for the 9th grade class will be analyzed. Finally, this study will gather teachers’, administrators’, and students’ perspectives on how participation in an online learning program contributed to their learning of math as well as how to improve the program for future implementation.

Research Questions

Three research questions will guide this investigation:

1. What were the expected outcomes of a vocational technical high school administration with regards to online math instruction for incoming 9th graders?
2. How did use of an online learning environment effect students’ math skills when used independently and in a hybrid math class over the summer?

3. How did students perceive the online learning environment having assisted them in the development of their math skills over the summer and in preparing them for the upcoming school year?

The theoretical frameworks, literature review and research methodologies that guide this research follow. Additionally, the validity and credibility of this investigation and the information on the protection of human subjects is included in this chapter.

Theoretical Framework

Sociocultural learning theory. Vygotsky's sociocultural approach provides the context for the historical and cultural portion of this research. "A child is not a constant, universal organism operating in a vacuum...The sociocultural-historical context defines and shapes children and their experiences" according to Miller (2002, p. 373). Culture is further defined as –"shared beliefs, values, knowledge, skills, structural relationships ways of doing things (customs), socialization practices and symbol systems" (Miller, 2002, p.374). Since today's American culture is becoming increasingly more connected via technologies it is prudent to explore the culture within which we are teaching students. As we graduate our students into this technology enriched American society, it is incumbent upon us to prepare them with the tools necessary to succeed. Today's society incorporates computer technologies into everyday life and students are going to need to be fluent in the various technologies to be successful after their formal education is completed. Thus it is valuable to begin the introduction to various online educational programs before graduation from formal schooling. While each school has its own culture, public schools also represent the greater society from which our students come and will eventually be returning via the workforce. It is important to provide some background and context for this study. The school which is being researched has a distinctive culture and student body given that it is a vocational technical high

school populated with pupils who applied and are selected to attend a secondary school where half of the curriculum is provided in a traditional academic setting and the other half is delivered by way of a hands-on vocation-based curriculum. The setting is important in understanding and interpreting the results of this study, particularly regarding teachers', administrators' and students' perspective of the utility and efficacy of an online learning program. It will also provide information about how the administration incorporates technologies into student's daily school experiences.

According to Braundy (2004) "technology literacy was defined, though not so named, by John Dewey at the turn of the past century. Dewey described how schooling could lay the groundwork for understanding the practice and implications of producing for society's needs. He talked about the importance of technologically literate individuals and collective knowledge production in the development of thoughtful citizens capable of critical thinking" (p. 1). He also advocated many of the interdisciplinary themes that are being called for currently. In 1915, John Dewey further identified that successful learning occurs when educators "relate the school to life, and all studies are of necessity correlated" (Dewey, *The School and Society*, 2001, p. 55).

Dewey's visionary way of thinking continues today as educators strive to help students gain the necessary 21st century skills for success. According to a white paper published by Massachusetts' Partnership for 21st Century Skills (Intellectual and Policy Foundations, 2007), "Throughout human history, education has been shaped by the societal needs of the societies in which it is set. Education, after all, is the attempt to convey from one generation to the next the skills, values, and knowledge that are needed for successful life" (p. 1).

Bruner (1996) further supports this idea when he states, "What we resolve to do in school only makes sense when considered in the broader context of what the society intends to accomplish through its educational investment in the young" (p. ix). This study is an effort to try

to understand the impact of one school's introduction of a new approach to mathematics instruction.

Online learning theory. Online learning theory is another way to view this research. According to Dede, (n.d.) "education should prepare students for a world in which computers do almost all types of routine cognitive tasks and in which expert thinking and complex communications are the core intellectual skills for prosperity" (p.12). Dede is a respected researcher in this area of education and author of numerous articles on the online learning phenomenon. Dede's work builds upon Bruner's 1966 theory of instruction where he notes "We teach a subject not to produce little living libraries on that subject, but rather to get a student to think mathematically for himself, to consider matters as an historian does, to take part in the process of knowledge-getting. Knowing is process, not a product" (Smith, 2001, p. 4).

Dede (n.d.) explains, "Current trends suggest that more students will run their own businesses rather than work for others and, as adults, must constantly, quickly, and efficiently learn new skills and information to be effective entrepreneurs" (p. 14). Given these new realities in the work force, technology, critical thinking, the ability to absorb new information and apply it to novel problems will be necessary for future success in the competitive global community. The school which is the site of this investigation, like many other public schools in the United States is currently not designed for students to learn in this fashion or for teachers to instruct in this manner. Yet, limited research has occurred to date to guide the transition to a technology based learning environment.

According to Anderson (2010), "In many ways, learning and teaching in an online environment are much like teaching and learning in any other formal educational context: learners' needs are assessed, content is negotiated or prescribed, learning activities are

orchestrated, and learning is assessed. The pervasive effect of the online medium, however, creates a unique environment for teaching and learning. The most compelling feature of this context is the capacity for shifting the time and place of the educational interaction” (pp. 343-344).

I would suggest that another aspect of student learning to consider when using online learning programs is the limited ability of the teacher to gather information about a student’s preferred learning style, as well as his/her academic strengths and weaknesses. This is especially evident with purchased online learning programs such as the Study Island program that is part of this investigation. There is no online interaction with a human instructor with this software package. The computer program provides standardized approaches to the instruction and feedback for all students utilizing it. Additionally, with this specific math program, there is no ability to tailor the curriculum to individual student needs. All preprogrammed curriculum materials are presented in a written format with no alternative methods of presentation. Given that many students who apply to a vocational technical high school have self-selected to a more “hands on” approach to their learning, another aspect of online learning to consider is how it impacts students who are less successful with this approach to their academic endeavors. Additionally, to be successful with this program a strong command of the written language is required. These types of students may be at a disadvantage in an online learning situation where a teacher is not immediately available to help those who are less capable in their reading and writing abilities.

Anderson (2010) further states, “The challenge for teachers and course developers working in an online learning context, therefore, is to construct a learning environment that is simultaneously learner-centred, content-centred, community-centred, and assessment-centred. There is no single best media of online learning nor is there a formulaic specification that dictates

the type of interaction most conducive to learning in all domains and with all learners” (p. 66). She further warns that “We do need [online learning] theory, however to help us envision how education can best take advantage of the enhanced communication, information retrieval, creative tools, and management capability provided by the Net. It is all too easy to consider new innovations in a horseless-carriage manner, and attempt to develop new actions based on old adaptations to now obsolete contexts” (p. 46). Given the limited scholarly literature that is currently available to guide the development of the many online learning programs, it is prudent to further explore the benefits and limitations of this approach to teaching and learning. This doctoral study is an effort to explore how online learning impacts newly accepted 9th grade students at a vocational technical high school.

According to Mayes & deFreitas (2004) “There are really no models of e-learning *per se* – only e-enhancements of models of learning. That is to say, using technology to achieve better learning outcomes, or a more effective assessment of these outcomes, or a more cost-efficient way of bringing the learning environment to the learners” (p. 4). This would suggest there is no need for the development of a separate online learning theory.

Miller and King (2003), provide a different perspective in that they believe that “distance education is fundamentally different from traditional classroom education...One of the concerns consistently voiced about distance education is the lack of human contact and feelings of isolation. Though learners communicate with the instructor and other learners via bulletin boards, e-mails, listservs, etc., the ‘personal touch’ of a regular classroom doesn’t exist” (p. 290).

Another consideration with online learning according to Miller and King (2003) “is a number of factors that contribute to course non-completion in distance education: lack of feedback; feelings of isolation; frustrations with the technology; anxiety; and confusion” (p. 286).

Thus there are differing perspectives amongst those who are currently researching and publishing articles about the online learning phenomenon and what comprises a theory of online learning.

Dede (n.d.) further suggests we should “develop alternative models of education that use emerging technologies to reinvent many aspects of teaching, learning and schooling” (p. 11). This school’s new mathematics initiative is a real time effort to redesign and reinvent education and teaching. However, more research is necessary to determine how best to teach students the necessary academic and technological skills to succeed in today’s workforce. As a member state of the Partnership for 21st Century Skills, and more recently recipient of federal “Race to the Top” monies, the Massachusetts education system is moving towards redesigning the way public education is provided to all students. The technological proficiency gained through online learning is just one component of this effort to teach students the necessary 21st century skills to succeed in our computer oriented society and workforce. With the push to gain 21st Century skills, now more than ever, schools have a responsibility to insure that students have the technology skills to succeed after graduation.

Chapter 2: Literature Review

Because of the various perspectives this study draws from, this research project by necessity includes a review of scholarly literature from both sociocultural learning and online learning. Additional literature from the areas of policy and education research will provide background and give a historical perspective to this project all within the context of the two major theoretical frameworks – sociocultural learning and online learning.

It was important to reach beyond education research given numerous political, community and economic factors impacting the success or failure of any initiative as well as to further refine and define this research effort. With Massachusetts currently participating in the Race to the Top

Federal Initiative, it is also relevant to explore how public policy is impacting the practical realities of education today. The Partnership for 21st Century skills was also considered as it has been calling for a shift in how students in Massachusetts are educated and prepared for gainful employment in today's ever evolving and changing technological society.

Given the current lack of controlled research in K-12 public education, this literature search needed to include research on post-secondary online education opportunities. Within the last few years there has been more interest in the efficacy of higher education and the variety of approaches to curriculum delivery currently being utilized. Given the proliferation of both online and hybrid learning opportunities becoming available across the education continuum it was prudent to explore all recent investigations regardless of educational level targeted.

Theoretical Framework

Sociocultural learning. From a sociocultural perspective, John Dewey (1915) wrote in his essay, *The School and Social Progress*: “The modification going on in the method and curriculum of education is as much a product of the changed social situation, and as much an effort to meet the needs of the new society that is forming, as are changes in modes of industry and commerce” (p. 6). He could easily have written this today given the dramatic cultural shifts that are occurring with the incorporation of technologies in American society today. My research project directly investigated this cultural shift towards online learning opportunities and away from traditional face-to-face classroom interactions.

Dede (2007) points out that: “At this point in history, the primary barriers to altering curricular, pedagogical, and assessment practices toward the transformative vision of ICT [information and computer technology] in education ...are not conceptual, technical, or economic, but instead *psychological, political, and cultural*. We now have all the means necessary to

implement alternative models of education that truly prepare all students for a future very different from the immediate past. Whether we have the professional commitment and societal will to actualize such a vision remains to be seen” (p. 35). Though a century apart in their experiences, both Dewey and Dede recognize the relevance of adjusting education to meet the needs of both students and the society they will eventually be returning to after completion of their formal education experiences.

The call for improved and increased science, technology, engineering and math (STEM) education in the United States public education system has also led many schools to revisit and redesign their offerings in these crucial areas of education. According to the National Action Plan for Addressing the Critical Needs of the United States Science, Technology, Engineering and Mathematics Education System (2007): “Within the current education system, U.S. students are not obtaining the STEM knowledge they need to succeed” (p. 3). The report further points out that “many high schools provide a curriculum that is uninspiring, poorly aligned, outdated, lacking in rigor, and fraught with low expectations. The net result is that almost 30 percent of high school graduates enter college unprepared for first-year coursework or arrive at the workplace without the mathematical, scientific, and technical skills that employers requires” (p. 5). The effective use of computers by both students and teachers in the classroom can help address this challenging situation. While computers in school are more common than ever, the use of other more recent gaming and social networking technologies has not yet entered the mainstream classroom. Klopfer, Osterweil, Groff, & Haas (2009) report on the evolution of technologies in relationship to teaching and encourage the investigation of these new technologies. “Undoubtedly, without these recent technologies (i.e. digital games, Web 2.0, etc.) in the classroom, strong lessons can still be achieved, but there’s a sharp disconnect between the way students are taught in school and the

way the outside world approaches socialization, meaning-making, and accomplishments. It is critical that education not only seek to mitigate this disconnect in order to make these two ‘worlds’ more seamless, but of course also to leverage the power of these emerging technologies for instructional gain” (Klopfer et al., 2009, p. 3). The authors “advocate for an *evolution* in educational practices and approaches to instruction, which not only align with the processes and operations of the world outside of school, but also leverage the emerging power and potential of these new processes and technologies.” (Klopfer et al., 2009, p. 3) Like John Dewey did over 100 years ago, they advocate for connecting teaching to the greater world surrounding the students to make learning meaningful and relevant.

Online Learning. According to Rice (2009) in summarizing a study utilizing the Delphi Method of group communication, “the following priority areas for K-12 distance education over the next five years [are] (in order of importance): 1) evaluation of course design and delivery, 2) best practice, 3) accountability, 4) access, 5) online learning/learners, 6) professional development, 7) accreditation/standards, 8) funding, and 9) technology” (p. 163). Rice’s 2009 study points out the numerous issues that must be addressed by our educational policies as well as by current researchers to inform the policy currently being created. Despite the proliferation of technologies available in schools and the increasing number of online learning opportunities, there remains much to be considered and investigated.

Like the United States, other countries are experimenting and exploring the use of computer technologies in their educational institutions. A more in-depth investigation will result in a more comprehensive understanding of the phenomenon while providing the opportunity to learn from other nations and cultures that may be currently utilizing online learning opportunities. One such study is from the University of Waikato in New Zealand. Study authors, Khoo, Forret &

Cowie found in a 2010 study that “Successful online teaching and learning was characterized as a social interactive process such as that embodies within learning communities. Teaching practices and responsibilities associated with four lecturer roles were crucial to this process-pedagogical, managerial, social and technological” (p. 17). This study was a recent attempt to further determine more specifically the most important aspects of online learning to maximize student success.

Another study originating in Taiwan by Yeh (2010) investigated the “relationships among online behaviors, online roles, and online learning communities” (p 140). Yeh’s (2010) study investigated 32 pre-service teachers and analyzed online group discussions. “Analyses of online group discussions reveals the following: (a) of thirteen identified online behaviors, the most common were constructing a positive atmosphere, providing opinions for group assignments, and providing reminders of assignment – related work; (b) of eight online roles identified within a group, the most common roles were information providers, opinion providers, and troublemakers; (c) four online learning communities based on ‘collaboration’ and ‘participation’ were identified” (Yeh, 2010, p. 140). These findings suggest that there are many behaviors to consider when implementing an online learning program as well as provide insight into the complex reasons that a student may or may not succeed with this educational approach.

To date many conflicting studies are being published with regard to the potential benefits and successes of online learning programs. There is no current consensus on the success or failure of this approach to teaching and learning. According to Lips (2010) in a Heritage Foundation funded study, “Students appear to be benefiting from online learning programs. A meta-analysis of empirical evidence on online learning programs found that students learn as well or better on line as in a traditional school setting. Other potential benefits included expanded access to talented teachers, customized learning, more flexibility for families, and improved school productivity” (p.

9). In comparison, DiPietro, Ferdig, Black & Preston (2008) found “Very little is known about best practices specifically related to teaching in K-12 online settings” (p. 10).

In contrast, Tienken & Maher (2008) when investigating the influence of computer-assisted instruction (CAI) on eighth grade mathematics achievement, found “the results suggest that the CAI intervention did not improve student achievement significantly ($p > .05$). In two categories, students who received the CAI performed significantly lower than their peers in the comparison group”(p.1). Their findings further suggest “CAI did not influence positively the achievement of the regular education students who struggled academically. In fact, the students in the control group who scored in the lowest quartile of the TerraNova pretest significantly outscored their peers in the experimental group. This suggests that the CAI program may have had a negative influence on some of the district’s academically weakest students “ (p. 12).

Alternately, a 2008 study by Hannafin & Foshay suggests that use of a computer-based instructional course (CBI) when used as a remediation strategy for students at risk of failing the Massachusetts Math MCAS test (one of the state’s competency tests required to earn a high school diploma) improved student success. This study found that “overall scores of all 10th graders increased significantly compared to their 8th - grade scores, students who participated in CBI course improved more than the students who did not” (Hannafin & Foshay, 2008, p. 147).

Much confusion remains with regard to the effectiveness of online learning and many questions remain yet to be answered. It is evident that there are differing perspectives and approaches to investigating and understanding the introduction of technology to the educational system and the need for more research in this area.

Another question to be answered definitively is how much does technology proficiency affect the use of online learning programs. According to Judson (2009), studies to date have not

yet “investigated technology literacy itself as a variable that affects student achievement” (p. 272). Many studies have addressed whether or not the existence or use of technologies lead to academic gains. This study approached technology and student achievement from the perspective of looking at *when* the students gained technology literacy and was there positive effects in the traditional subject areas. Judson (2009) proposes that student success is not necessarily correlated with “increased access to technology but increased ability with technology that can serve as a catalyst for improvement in academic subjects. More specifically, it is conjecture that it is the increasing or enhancement of technology literacy that promotes growth” (p. 273).

Baker (2010) looked at the online learning experience from yet another perspective when the author investigated whether instructor immediacy and presence impacted online learning. Baker (2010), “found a statistically significant positive relationship between instructor immediacy and presence. It also found that the linear combination of instructor immediacy and presence is statistically significant predictor of student affective learning, cognition, and motivation” (p.1). This finding is relevant as it suggests that a hybrid model of instruction which combines both online learning with face-to-face instruction should yield a better student learning experience and improved academic outcome. This study further investigated the value of the hybrid model offered at one vocational technical high school versus the online only approach to learning.

Yet another challenge to online learning is the digital divide in this country which will continue to limit the ability of students to access online learning programs. According to the National Center for Education Statistics (Students and computer access, n.d.), “in 2001, the ratio of students to instructional computers with Internet access in public schools was 5 to 1” (p.1). Unfortunately, in schools with high concentrations of students in poverty, the ratio is higher at approximately 6.8 students to 1 computer. While we are making progress with computer access at

schools, only 21 percent of the students used computers at home for school work (p.1).

Collins and Halverson (2009) point out that “technologies that seem to create more opportunities of equity in learning may well serve to reinforce the widening economic gap. The challenge of technology-driven learning opportunities rests on the questions of access. More and more people with means are able to purchase computer technologies that lead to new media literacies. One of the great promises of the traditional school system was to engage all students with common learning technologies. The different access in homes limits the abilities of schools to equitably distribute access to new learning technologies” (p. 7).

In my personal experience as a teacher with students who do have home computers, they tend to have older ones that do not support many of today’s computer programs and platforms that require a significant amount of memory and/or processing speed. Unfortunately, given the current economic climate, community libraries with computers and Internet access are cutting back their hours which further limits non-school access to technology. Given the need for 21st Century skills development and that technologies are a vital part of future employment opportunities and continued growth of the society, the digital divide needs to be addressed to insure equity in access for all students.

There are currently numerous online learning programs available for use in the classroom with limited scholarly research to support the marketing claims of these products. Following an extensive literature search for recent research within the frameworks of both sociocultural and online learning theories, it is evident there remain many different perspectives and opinions of the value and challenges of education programs offered in an online format. Thus it is prudent to learn as much as possible and identify the best method of instruction for students as more schools are gaining access to technologies and online learning opportunities. This study has added to the

body of literature specifically regarding the use of one online learning program for teaching mathematics to the incoming 9th grade class of a suburban vocational technical high school.

Chapter 3: Research Design

Research Questions

For the purpose of this study, the following research questions were pursued:

1. What were the expected outcomes of a vocational technical high school administration with regards to online math instruction for incoming 9th graders?
2. How did use of an online learning environment effect students' math skills when used independently and in a hybrid math class over the summer?
3. How did students perceive the online learning environment having assisted them in the development of their math skills over the summer and in preparing them for the upcoming school year?

Research Approach

This research is a program evaluation outcome study. According to Billings and Halstead (2005), "The primary purpose of program evaluation is to judge the merit or worth of the total program being evaluated, as well as the individual elements of that program" (pp. 543-544). This type of research approach is further described as "a form of applied research that scrutinizes how well a particular programme, practice, procedure or policy is operating. Evaluation researchers use both quantitative and qualitative research data to construct a collective picture of the programme under evaluation" (Tavakol, Gruppen & Torabe, 2010).

The rationale for selection of this research method lies in the fact that given the increase in online learning opportunities available today, it is worthwhile to evaluate the total program utilizing both quantitative and qualitative measures as well as the responses of the various stakeholders.

Investigating the effectiveness of an online mathematics learning program introduced

to the incoming freshman class of a vocational technical high school in New England

provides information to other schools considering this approach to enhancing math skills.

This outcomes study drew from five sources of data and the accompanying data analysis:

1. A statistical analysis of the differences between the spring and fall 2010 NWEA math assessment undertaken by all incoming 9th grade students to the high school
2. A review of the survey taken by all incoming 9th grade students after using the online math program during the summer of 2010
3. An analysis of end of year math grades for all 9th grade students
4. A qualitative analysis of expectations by high school administrators regarding the impact of students' use of the online math program
5. A review of students' perspectives regarding how the online program supported them in their math learning over the summer and prepared them for ninth grade based on focus groups

NWEA Testing. This investigation included a statistical analysis of Northwest Evaluation Association (NWEA) math scores prior to and after participating in the summer math instruction either online or in a more traditional hybrid classroom model. The study utilized a secondary data analysis of change between the spring and fall 2010 NWEA math assessments administered to the students accepted to the vocational school's incoming 9th grade class. The research compared students' use of either the online program only or participation in a hybrid summer school class and determined if one method is more effective than the other. NWEA is an online testing program that measures a student's achievement and academic growth, independent of grade, across time. The student's performance is provided in the form of a tool called a "MAP" – Measures of Academic Progress. These performance measures were determined as a result of a

2008 NWEA Rasch Units (RIT) Scale Norms Study, which “include data from over 2.8 million students from 6, 905 schools in 1,123 districts located in 48 states” (2008 Normative Data, p. 1). According to materials published by NWEA, “status norms were determined from a stratified sample of students representing the national school age population, more specifically, ethnicity and socio-economic status at each grade level”(2008 Normative Data, p. 1).

Incoming 9th grade students were assigned to a learning group – either online or a hybrid in school instruction program based on their 8th grade NWEA scores and any applicable education plans. All students were retested in the fall of their 9th grade year. An analysis of covariance (ANCOVA) was used to test for differences in gain across three different groups of students: (1) students who did not use the online program; (2) students who used the online program independently; and (3) students who used the online program with support of an instructor in a hybrid summer math class.

End of year math grades. To provide a comprehensive understanding of the incoming 9th grade students’ math proficiency following participation in the summer math program final math grades were analyzed to determine if one group of students – online only; online within in the context of the hybrid classroom; or those with no participation at all – earned higher end of the year math grades.

Student survey. A student survey was included in the fall testing session to gather students perspectives on their summer learning experiences. Careful thought was given to the development of an online student survey to be completed following Fall 2010 testing session. Questions ranged from potential barriers to participation and student engagement to self-perceptions surrounding math abilities. The surveys were reviewed to assess students’ overall perspectives on their summer math experiences. The survey was a simple Likert Scale

questionnaire, which gave students the opportunity to share their summer math experiences. A summary of students' responses across items was included contributing to the understanding of students' perceptions of the online program and the degree to which it assisted them in their learning and prepared them for 9th grade. These surveys also provided information regarding the potential barriers students may have encountered with regard to accessing the online learning program as well as gathered information about self-perceptions of their math skills. Finally the surveys gathered information about whether students would consider taking another online course and if they believe the summer program helped prepare them for 9th grade math. A review of the survey data was conducted to identify any of patterns of responses and to determine follow up questions to include during focus group discussions. Data considered included a review of the student surveys regarding their perspectives on the summer learning experience using the online learning environment, their personal assumptions regarding their math abilities, and the degree to which use of the online learning environment independently or in a hybrid learning class prepared them for their 9th grade math classes.

Interviews. Interviews with administrators and the summer school hybrid math class instructor also provided deeper understanding of the overall experience for all stakeholders. These interviews identified expectations and understandings of the online learning initiative. Interviews were immediately transcribed and analyzed for any commonalities and differences to deepen the understanding of the online learning program as well as the newly created summer hybrid program to determine the areas in need of improvement as well as to decide whether to continue the initiative with future incoming 9th grade classes. (See Appendix G for administrator interview questions).

Student focus groups. In addition to the analysis of the survey data and the NWEA

achievement scores, it was hoped that a representative sample of students from across groups would be invited to participate in focus groups to gather more in-depth perspective of their summer mathematics program experiences. The purpose of the focus groups was to allow the investigator to query students in more detail regarding these same perspectives as well as the degree to which these students believe the online learning environment effectively prepared them for their ninth grade math classes. Unfortunately, the opportunity to conduct focus groups with students didn't come until the end of the school year and students' schedules did not allow for this activity to be completed.

Methodology

Site and participants. The site of this research is a regional vocational technical high school (VTHS) that serves nine communities. A large percentage of the students come from a highly diverse city with a multitude of inner city challenges. In the 2009-10 academic year, the students were categorized by the Massachusetts Department of Elementary and Secondary Education (DESE) as Low-income (48.5%); First language not English (16.5%) and Special Education (26.6%). According to the 2010-11 school profiles, the school serves 1,262 students who spend one week in academics and one week in vocational shop alternately throughout the year (School profiles, n.d.). This academic year VTHS decided to offer all incoming freshman the opportunity to participate in a summer learning opportunity regardless of their 8th grade NWEA scores. While the students with the lowest scores were bussed into the school for a hybrid summer school class the remainder were offered online tutorial programs for the summer. Both MyAccess and Study Island programs (web-based instruction, practice, assessment and reporting programs built upon the Massachusetts State Education Frameworks) were purchased by the school and implemented in the summer of 2010. VTHS utilizes Study Island for the math and English

language arts instruction and MyAccess for writing instruction. Students were assigned a teacher mentor who was expected to make contact with them weekly to orient them to the school, the online learning programs and offer support as necessary for their transition from middle school to high school. This contact could either be face to face, by phone, email or other online communication. The students were expected to complete three hours of online learning weekly during the summer. If the student did not have access to a computer at home or at the local library, they were welcome to come to the school to use the school computers. In cases where the student could not get transportation, the school provided bus service to the school. To further motivate the students to participate, they were offered the opportunity to select any elective course in the fall semester if they completed the required work. If they did not complete the work outlined, they were automatically assigned to an academic support class in the fall schedule. Mentors contacted parents if the student did not engage in the summer academic expectations in an effort to build a relationship with the family as a partner in the student's education plans.

The researcher's relationship to the site and participants. This researcher is a special education teacher employed by the school the research was conducted at. She is currently assigned as a co-teacher in the upper level science classes (physics, chemistry and 21st Century Science, Technology and Engineering) and thus has no interaction with the incoming 9th grade class. In her tenure at the school she has always been assigned to co-teach upper level math and science classes and thus has no interaction with 9th grade students. She is a colleague to the summer school math instructor and mentor teachers and subordinate to the administrators interviewed for this proposed research project.

Comparing improvement in math achievement scores across groups. The NWEA assessment is an online testing system designed to show individual student progress over time

within the Massachusetts State Frameworks for math, English language arts, and science. For purposes of this study only math scores were considered. The assessment is a tool that utilizes Rasch Units (RIT), which measures student academic growth over time and is independent of grade level. (RIT Reference Charts, 2005) This assessment tool is utilized by VTHS to test all incoming freshman in the spring of their 8th grade academic year. Traditionally, the students most in need of improvement are then assigned to a remedial summer school program, which they are expected to attend for 12 hours a week for six weeks at VTHS. Students with specific education plans calling for an extended school year are also included in this group. Through traditional classroom instruction activities as well as access to online learning programs, the students worked with teachers to enhance their knowledge and skills prior to entering their 9th grade year in the fall. This hybrid model of summer school was the first ever offered at VTHS. Upon arrival to VTHS in the fall, all incoming 9th grade students were retested with the NWEA assessment to determine change in math skills.

NWEA assessment scores in Spring 2010 and Fall 2010 were compared across the two groups of student participants: online learning only or a hybrid classroom with a blend of face-to-face instruction and online learning. An analysis of covariance was utilized to determine the significance of the findings.

Data collection

Quantitative data. Students' test scores from Spring and Fall 2010, before and after use of the online learning program - either independently or in the context of a hybrid learning class - were collected and analyzed to determine effectiveness of the online approach to instruction versus the hybrid instruction classroom which blends traditional teacher directed instruction with the online learning program. The NWEA testing provides information about a student's academic

growth over time and is independent of grade level. When a student is tested online, if a certain threshold of incorrect answers is reached the computer program automatically resets the test to a lower level in order to accurately determine a student's abilities. The test is norm referenced and it provides valuable data about how a student is performing and at what level to begin instruction.

End of year math grades. At the end of the 2010-11 academic year, 9th grade student math grades were investigated and analyzed to investigate whether one group of students – online only; online within the context of the hybrid classroom; or those with no participation at all – earned higher end of the year math grades.

Student surveys. In Fall 2010, all students completed an online survey and provided perspectives of their summer experiences specific to math instruction. The format of this survey, provided online, included questions regarding students' use of the online learning program, their access to computers and the degree to which they perceived the online learning program to improve their math skills. Additionally, it questioned whether they would consider taking another online course in the future. (Appendices C and D include the survey instruments)

Interviews. Administrators and hybrid instructor interviews were conducted. The interview was comprised of approximately 20 questions. Administrator questions targeted background information on the decision to implement the new online learning program, decision-making processes with software selection and expectations of the new summer school initiative. Administrator interview questions are provided in Appendix G. Teacher interview questions focused on specific challenges to the new program and barriers encountered. Teacher interview questions are provided in Appendix F.

Focus groups: As mentioned before, it was hoped that the researcher would have been able to convene students representative of the population involved in the research study. Because of end of year scheduling, the researcher was unable to engage students in focus groups.

Data analysis

Statistical analysis of NWEA assessed math gains dependent on use or non-use of the online math program and hybrid class. Light, Singer, & Willett (1990) state the use of “Covariates are predictors that you expect to be related to the outcome, and whose impact you would like to disentangle from the impact of the predictors in which you are really interested” (p. 200). Thus it was my plan to use an analysis of covariance (ANCOVA) to understand the data collected to more thoroughly evaluate and interpret the findings of this study. An analysis of covariance was used to determine whether students’ use of the online math program independent and in the context of a hybrid course impacted their math abilities. The covariate was students’ math achievement scores as determined by the NWEA in Spring 2010. The dependent variable was the Fall 2010 NWEA test scores, and the three possible treatment factors were (1) no use of the online program, (2) use of the online program, and (3) use of the online program in the context of a hybrid summer math class.

Student scores in the spring and fall of 2010 were statistically analyzed for significant pre- and post-treatment differences across participation groups: no use of the online learning environment, independent use of the online learning program, and use of the online learning environment in the context of a hybrid class. An analysis of covariance determined significance across groups, with the spring score serving as a co-dependent variable and use of the online environment independently or in the context of a hybrid class as dependent variables. Program administrators hypothesized that student scores would increase significantly more for those

students participating in the online and hybrid math programs than students not using the online math program. Comparing improvement in math achievement scores across these three groups helped determine if their hypothesis was valid.

Quantitative analysis of interviews and student surveys. In addition to analysis of the NWEA and Study Island data, this investigator also reviewed surveys and personal interview responses to provide a fuller picture of the experiences of the students, teachers, and administrators with regard to the overall successes and challenges of the introduction of the online learning and in school hybrid math programs during the summer. Patterns of answers were further considered as part of the overall findings in this report. A thick description with extensive details of the school, student body and administration goals and objectives provides context for this aspect of the research project. Survey data revealed the degree to which students using the online math program independently versus the in school hybrid instructional format believed that the online program was helpful and better prepared them for 9th grade. Survey answers were quantified showing percentages of responses to each question. This information helped identify the strengths and weaknesses of the programs from a student's perspective. Additionally, potential barriers to success were gleaned from the survey data.

Qualitative Data

School Personnel Interviews. A review of administrators' and hybrid instructor's interviews attempted to identify expected outcomes across program actors and their rationale for those outcomes in terms of student improvement in math RIT scores. All interviews were transcribed and reviewed for patterns, themes and distinctive perspectives. After this analysis within each interview, the content, themes, and perspectives across interviews were compared to identify commonalities and distinctive differences. These commonalities and differences were

catalogued and analyzed in an effort to identify meaningful ways to improve the delivery of a summer school math curriculum for future incoming freshman classes.

Validity and Credibility

The following are areas of concern and potential challenges to the validity and credibility of this study and are presented immediately to inform the reader of the limitations of this investigation:

- The NWEA assessment tool was developed by a for-profit educational testing company with research supporting the validity provided by the company.
- The instructor for the in school summer hybrid program was not a licensed high school math teacher.
- While it is hoped that the students responded honestly to questions on the survey, depending on how they felt about the program or summer school in general, they may not have been forthright in their answers.
- Initial testing in Spring 2010 was completed in small groups of students while Fall 2010 testing occurred during a study hall period with many more students present, thus creating different testing environments for each session.
- Student focus groups were not conducted due to end of the year scheduling conflicts. This resulted in no opportunity to follow up on survey results and gain individual perspectives and experiences.
- The research was conducted in a school district with numerous student and staff computers, laptops, smartboards and other teaching technologies in each classroom and public areas of the building. The whole school has Wi-Fi access as well as direct cable Internet access. Students have access to computers before and after school as well as

during lunchtime. The sheer number of technologies available to students and faculty might limit the ability to replicate this study in a district with fewer resources, limited access to technologies and with faculty less proficient in the use of them.

- Given this was a new approach to summer school, the program evolved as it was implemented in an effort to improve student outcomes and with limited concern for the original program designed in Spring 2010.

Protection of Human Subjects

This project utilized a secondary data review of information already collected on the eighth graders accepted to the school and then again collected in the fall of their 9th grade year. Additionally, a student survey was completed following the Fall 2010 9th grade testing session. The students remained anonymous and identified only by their district identification numbers. Research plans included the interviewing faculty and administration associated with both online and the hybrid summer school mathematics classes. It was hoped that focus groups of students could have been convened to gather qualitative data surrounding the online vs. traditional classroom experiences, however due to scheduling difficulties these groups were unable to meet.

All appropriate protocols for human subject research were adhered to throughout this investigation. There was no risk in participating in this research study. All participants or their guardians were informed of the goals and expectations of this research and were asked to sign an informed consent form prior to participation. Informed Consent Form attached in Appendix D.

Chapter 4: Report of Research Findings

This investigation focused on the introduction of an online math program for incoming 9th grade students at a mid-sized regional vocational technical high school (VTHS) in New England. Students apply to attend this school and upon selection for admission they are evaluated using the

NWEA assessment tool in the spring of their 8th grade year. They are tested in both mathematics and English language arts to determine their class placement upon arrival in the fall.

In the Spring 2010 administration of the VTHS decided to implement an online learning program in mathematics and the Study Island software was selected and purchased. Based on student NWEA scores and any relevant education plans students were either selected to attend a hybrid summer school course offered at the school or to complete online work independently during the summer months prior to entering their 9th grade year. In the Fall of 2010, at the beginning of the 9th grade year, these incoming students were retested on the NWEA assessment tool. This study utilized a secondary data review of the spring and fall NWEA scores and determines how participation in the online program, the hybrid program, or no participation impacted student math proficiency as measured on the NWEA test in the fall in comparison to the NWEA test score in the spring.

In addition to the NWEA testing, students completed surveys in the fall following their NWEA test session. These surveys were used to gain additional information regarding students' perceptions of their summer assignment and the degree to which students use of the program or their participation in the hybrid summer school program helped them. Two administrators and the summer school instructor were also interviewed for their perspectives regarding their expectations for student use of the online math program or participation in the hybrid math program.

Finally, students' year-end math grades for their 9th grade year were analyzed to determine if there was any significant relationship between their use of the online math program or participation in the summer hybrid class and their academic success in their 9th grade math classes.

Prior to the analysis of any of the data, this researcher had two working hypotheses:

- Hypothesis 1: Students who independently used the online learning math program will evidence significantly greater gains in their NWEA math scores from spring to fall than those students who did not use the online math program.
- Hypothesis 2: Students who participated in the hybrid math summer school class, which included use of the online math program, will evidence significantly greater gains in their NWEA math scores from spring to fall than students who did not use the program as well as those students who used the program independently.

These two hypotheses framed the following three research questions:

1. What were the expected outcomes of a vocational technical high school administration with regards to online math instruction for incoming 9th graders?
2. How did use of an online learning environment effect students' math skills when used independently and in a hybrid math class over the summer?
3. How did students perceive the online learning environment having assisted them in the development of their math skills over the summer and in preparing them for the upcoming school year?

The rest of this chapter presents the findings and an analysis of the data in response to these three questions.

Research Question #1: What were the expected outcomes of a vocational technical high school administration with regards to online math instruction for incoming 9th graders?

Administrator and Hybrid Instructor Interviews. Face to face interviews were conducted with the principal and the academic director to gain understanding of the expectations of the newly introduced online mathematics program. Administrator interviews were transcribed and carefully read three times to identify commonalities and differences as well as to deepen the

understanding of the expectations for the newly introduced online learning program and the hybrid summer school class. These interviews additionally investigated the assumptions and beliefs of the administrators responsible for their implementation. The interviews provided a deeper understanding of the overall experience from an administrative perspective.

The teacher who taught the hybrid summer school class was also interviewed for his perspectives and to gather a description of the actual day to day experiences within the hybrid classroom. This interview was immediately transcribed and then reviewed for a clearer understanding of the realities and practicalities of this new approach to a summer school math class at VTHS.

The following steps were used to analyze the interview data. Step 1: The researcher read through each transcript three times and identified commonalities and discrepancies between the interviewees. Step 2: Based on this review, the researcher identified common themes and perspectives that each interviewee contributed to the overall understanding of the new math programs offered to incoming 9th graders. Step 3: Specific comments were selected for inclusion in this report which best reflect each administrator's and the teacher's perspectives of the new programs. Step 4: Specific comments were then re-reviewed to further deepen the understanding of the perspectives of the various stakeholders represented.

As a result of these steps, the following priorities were identified and contributed to the overall findings of this research project: student responsibility for their own learning; importance of entering 9th grade with each student working at grade level; need to identify student abilities and differentiate accordingly; web-based learning experience; student engagement issues and finally challenges and benefits to these two approaches. Direct quotes follow as well as a summary of the three interviews.

Student responsibility for their own learning. The principal was emphatic when he stated, “Traditional summer school is stupid!” He further elaborated that he “believes that students should be taught to be responsible for their own learning [and] therefore we wanted all students to participate in their own learning over the summer regardless of their learning style or needs” (D. Wheeler, personal communication, January 19, 2011). The hybrid class instructor described the hybrid class students as having limited ability to take responsibility for their own learning which required him to control computer access throughout the sessions. “Students were more interested in games [offered in the Study Island software] than learning the math...I had to block their machines while instructing math and force them to pay attention” (B. Clifton, personal communication, June 13, 2011).

Importance of entering 9th grade with each student working at grade level. The academic director stated “There are 13 sending schools and every school is different. We have an 8th grade to 9th grade gap bigger than most schools. We can’t control the curriculum that the students bring into the 9th grade” (H. Driscoll, personal communication, January 25, 2011). Both the principal and the academic director expressed concerns that students be working at grade level upon entrance to the school in the fall. Both administrators believed that the summer school hybrid class and the student’s independent use of the online learning program were the best ways to insure that all students entered in the fall at grade level.

Need to identify student abilities and differentiate accordingly. The summer school instructor who facilitated the hybrid course recommended that the program could have been improved by “Leveling the students. Some couldn’t add, others were doing geometry. Some didn’t belong in there [summer school class] as they were really good in math” (B. Clifton, personal communication, June 13, 2011). The academic director spoke of “understanding students

on an individual level [as a result of these programs]” (H. Driscoll, personal communication, January 25, 2011). Both the teacher and the academic director were hoping to gain a better understanding of each student’s abilities as a result of this program, however, from the teacher’s point of view, different selection process could have been utilized when creating the hybrid class.

Web-based learning experience. According to the academic director, “Study Island was selected because I had experience with it and was told to buy an online program” (H. Driscoll, personal communication, January 25, 2011). She further stated, “I used Study Island elsewhere. No other pilots [programs] were tested before Study Island was selected” (H. Driscoll, personal communication, January 25, 2011). According to the principal, “There were some minimal technology limitations” (D. Wheeler, personal communication, January 19, 2011). Conversely, the summer school instructor said, “I had to train everyone on the computers” (B. Clifton, personal communication, June 13, 2011). With regard to the students needing assistance and clarification while on the Study Island program, the summer school instructor stated “sometimes it is more effective to have a teacher in the room...the ‘Help Menu’ was not as effective for the kids” (B. Clifton, personal communication, June 13, 2011). According to the administrators there were limited barriers to accessing the program for the students and if a student did not have access to a computer in the community, they were welcome to come to the school to use VTHS’s computers. Bus transportation was arranged if the student was unable to get the school independently.

Student engagement issues. According to the principal, “The biggest issue was maintaining continuous parental contact to motivate students” (D. Wheeler, personal communication, January 19, 2011). According to the summer school instructor “Students loved it. They got to play games. For summer school it was a positive experience” (B. Clifton, personal communication, June 13, 2011). The summer school instructor further stated, “One [student] did

not move past addition because he enjoyed the games so much” (B. Clifton, personal communication, June 13, 2011). Conversely, the summer school teacher also pointed out that “Students were bored to death with no hands on projects” (B. Clifton, personal communication, June 13, 2011). This insight is valuable given that VTHS is a vocational technical high school where students alternate one week of academics with one week of “hands on” vocational training in a shop setting. Consideration should be given to replicating this program with a “hands on” component given the student population that applies to attend a vocational technical high school.

Summary of interview results. Overall the interview of the two administrators and summer school math teacher provided understandings of how VTHS decided to change their summer school program in mathematics and the decision making process that was used prior to purchase of the Study Island online learning program. They also provided insight into the expectations each administrator had for this new approach to summer math learning. The principal’s open disregard of traditional summer school programming led to the academic director being instructed to find a web-based learning program for all students to access during the summer. The academic director’s familiarity from a previous school district with Study Island led to the selection of the program without any other options being investigated or piloted at VTHS. The summer school teacher implemented the new program as instructed.

Both administrators identified the same potential barrier to access and the solution VTHS provided – some of the students assigned to use the online learning program independently had no access to home computers that could support the Study Island software. The solution offered was that these students were identified and incorporated into the summer school bus schedule to allow them to come into VTHS to use the school’s computers to access Study Island.

The principal and the math instructor both identified that some students need more direct

instruction than an online learning program can provide. The math instructor also recommended leveling the students to improve the experience. Additionally, he stated, some “students were bored to death with no hands on projects” (B. Clifton, personal communication, June 13, 2011). This suggests the need for more differentiated lesson planning which addresses the multiple learning styles that students who attend a school such as VTHS bring to their learning.

Of particular interest were the following overall benefits which the principal outlined at interview:

1. “Eliminating the stigma of traditional summer school”
2. Providing continuous mentoring throughout the transition from 8th grade to 9th grade with one mentor for every student
3. Personalized orientation for students and families to our school culture and Study Island
4. We improved our data and information collection – email addresses, cellphone [numbers], etc.” (D. Wheeler, personal communication, January 19, 2011).

The summer school hybrid class instructor also provided a professional perspective on the overall process of teaching this hybrid course at VTHS. When asked if he enjoyed teaching in this model, he stated “Yes and no. It was easy, but not the most intellectually stimulating” (B. Clifton, personal communication, June 13, 2011).

This statement suggests that further research of teacher satisfaction and motivation in the hybrid classroom is warranted.

Overall, these interviews provided insight into the various perspectives that the two administrators and one faculty member brought to this new initiative in summer math instruction. As would be expected each had their own goals and expectations of the new program and each

had differing levels of insight into the student experiences. These perspectives are examples of the actual decision making process at this vocational technical high school and provide a deeper understanding of how this new program was conceptualized and implemented. The comments provided by the summer school hybrid instructor identified the challenges of this approach to math instruction for some students and were reported back to the administration to adjust the program for the summer program offered in 2011.

Challenges and Benefits to this approach. Utilizing this approach allowed this investigator to gain a deeper understanding of the motivations and expectations of the administrators in creating a new approach to summer school and preparing incoming 8th grade students for 9th grade math expectations. It also provided insight into the actual workings of the summer school hybrid classroom via the interview with the instructor. His perspectives and insights provided valuable information for future program planning and improvement of the hybrid course curriculum.

This approach also provided a perspective on how new programs are selected and implemented at the VTHS. The academic director was instructed by the principal to make a purchase of a web-based learning program and relied on her past experiences with a specific software program in the selection process rather than pilot multiple programs to gain a deeper understanding of the various options currently available. The hybrid summer school math instructor was provided the program and developed his traditional lessons to support the Study Island scope and sequence of math topics.

Both the online program and the hybrid summer school class which incorporated traditional instruction with an online component were introduced for the first time in the summer of 2010. The administrator interviews were conducted after the new summer math programs were

implemented and included perspectives and plans on how to improve the program for the upcoming year and in general contained an overall positive impression of the new initiative.

One of the challenges of these interviews was that they were completed in hindsight i.e. all three interviewees had the benefit of reflecting on the actual experience of hybrid summer school and the online learning opportunity which therefore may have influenced the opinions and perspectives provided. The hybrid class instructor was interviewed almost a year after teaching the session. Should future initiatives be implemented and researched for effectiveness, the interviews would be best conducted prior to the beginning of the program and again after implementation of any new program.

Summary of Research Findings. These interviews provided a deeper understanding of the expectations and goals of a regional vocational technical high school and its initial effort to implement a web-based math program. While the overall goal was to help students from 13 sending schools to be equally prepared for 9th grade math, the new program had unexpected benefits and challenges.

From the administrative perspective it was a very successful program with limited changes necessary for the upcoming summer. From the math instructor's perspective, most students struggled with the technology and others had difficulty with the primary approach to curriculum delivery being online suggesting the need for modification in future years.

Research Question #2: How did use of an online learning environment effect students' math skills when used independently and in a hybrid math class over the summer?

NWEA data analysis. This investigation includes a statistical analysis of NWEA math scores prior to and after participating in the summer math instruction either online or in a more traditional hybrid classroom model. A secondary data analysis of change between the spring and

fall 2010 NWEA math assessments administered to the students accepted to the vocational school's incoming 9th grade class was conducted. The research was initially designed to compare students' use of either the online program only or participation in a hybrid summer school class and to determine if one method is more effective than the other.

NWEA is an online testing program that measures a student's achievement and academic growth, independent of grade, across time. Incoming 9th grade students were assigned to a learning group – either online only or to a hybrid in school instruction program based on their spring 2010 NWEA scores and any applicable education plans. A third group of students was inadvertently created when some students chose to do no work at all on the Study Island program over the summer. All students were retested in the fall of their 9th grade year.

A total of 322 students either took the NWEA spring and/or fall NWEA test, but only a total of 155 students completed both the spring and fall administrations of the NWEA testing sessions. For the purpose of statistically assessing whether there was a significant difference in students' scores from fall to spring, only the 155 students taking both the spring and fall NWEA tests were included in the following analyses. Within this group, 15 of the students participated in the summer hybrid program, 76 worked online independently and, from a review of Study Island data, 64 were identified as not using the program at all. As can be seen in Table 1, for all students spring NWEA test scores ranged from 192 to 272, with a mean of 237.2 and standard deviation of 12.2. Fall NWEA test scores ranged from 196 to 270, with a mean of 236.2 and a standard deviation of 12.6. Table 1 provides an even greater breakdown of scores by group: students participating in the hybrid math class, students using the online math program independently, all students using the online program either independently or in the hybrid class, and students not using the program at all.

Table 1

Descriptive Statistics

Students & Test	N	Range	Min.	Max.	Mean	Std. Dev.
All Students Spring	155	80	192	272	237.3	12.2
All Students Fall	155	74	196	270	236.2	12.6
Hybrid Students Spring	15	65	192	257	234.5	17.7
Hybrid Students Fall	15	63	196	259	232.6	16.5
Online Only Students Spring	76	38	218	256	239.3	10.0
Online Only Students Fall	76	58	207	265	238.1	11.8
All Online Students Spring	91	65	192	257	238.5	11.6
All Online Students Fall	91	69	196	265	237.2	12.7
No Participation Spring	64	73	199	272	235.4	12.8
No Participation Fall	64	63	207	270	234.9	12.5

Note: Std. Dev. = Standard Deviation

Differences amongst groups. Multiple data points were collected and analyzed to provide a better understanding of the student's experience with the new summer math program.

Following a review of the descriptive statistics, an analysis of covariance ANCOVA was used to compare students' NWEA scores from the spring to the fall who used the online learning program, both in the hybrid context and independently, versus the students who did not use the program at all.

The ANCOVA analysis relies on the following three assumptions:

- **Linearity:** It is assumed that the covariate has a linear relationship with the dependent variable, i.e., that students' spring 2010 NWEA scores have a linear relationship with students' fall 2010 NWEA scores.
- **Homogeneity of Variance:** ANCOVA assumes the homogeneity of variance, that is the variance of the covariate and dependent variable of each group is equal to the

- respective variance of every other group in the analysis, no use of the online program, use of the online program, and use of the program within the context of a hybrid class.
- Homogeneity of Regression: ANCOVA assumes that homogeneity of regression exists, in this case that the correlation or slope of prediction between the dependent variable fall 2010 NWEA scores and covariate spring 2010 NWEA scores is equal for all levels of the independent variable or factor, no use of the online program, independent use of the online program, and use of the program in a hybrid class. In other words, for each level of the independent variable, the slope of the prediction of the dependent variable from the covariate must be equal.

In each of these cases, the data was in keeping with these assumptions.

An analysis of covariance ANCOVA was used to test for differences in NWEA scores from spring to fall across three different groups of students: (1) students who did not use the online program; (2) students who used the online program independently; and (3) students who used the online program with support of an instructor in a hybrid summer math class.

This analysis evidenced that there were no significant differences amongst the three groups of students dependent on their utilizing the online learning environment in the context of hybrid summer course, independent use of the online learning environment, or no use of the online learning program. The fall NWEA scores across the three different groups using the spring NWEA score as a covariant were not statistically different suggesting there was no difference in the fall NWEA scores as a result of using the online program independently or participating in the hybrid class, $F(2,151)=0.3; p=.74$.

A linear regression was also run with each group to arrive at a coefficient of determination r^2 as well as a linear slope of best fit between students' spring and fall NWEA scores for each

group. Figure 1 presents the scatter plot as well as the slope and coefficient of determination for each group's set of NWEA spring and fall NWEA scores. In each case, the relationship of spring and fall NWEA scores was significant (hybrid students ($r(15) = .95$, $p < .001$; online only students ($r(76) = .81$, $p < .001$); and not participating students ($r(65) = .84$, $p < .001$).

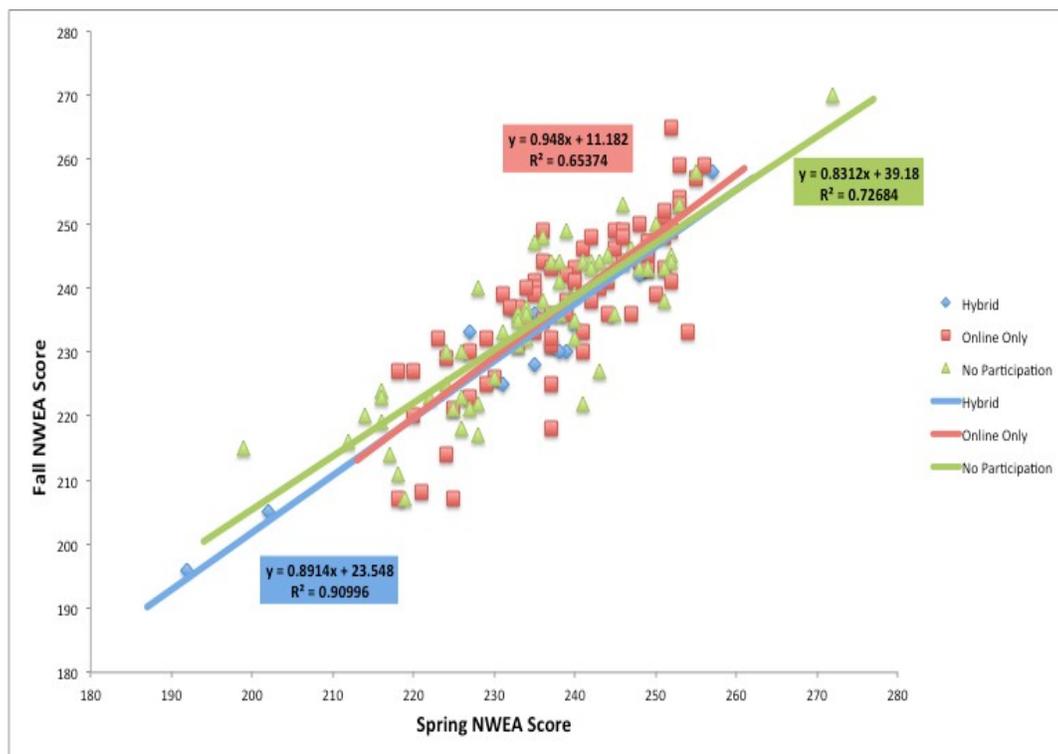


Figure 1. Spring and Fall NWEA Scores of Students who did not use Study Island and who did use Study Island independently or as part of a Hybrid class.

Given the lack of statistical significance amongst the three groups, it was decided to run a second ANCOVA analysis of the data combining the hybrid class students with those who worked independently online and then comparing that group to those who did not work online as assigned. This analysis also evidenced that there was no significant difference between those students using the online learning environment in the context of hybrid summer course or independently and those students who did not use of the online learning program at all. The fall NWEA scores across the two groups using the spring NWEA score as a covariant was not statistically significant

indicating that there was no difference in students' fall NWEA scores as a result of using the online learning program either independently or in the hybrid class, $F(1,152)=0.18; p=.67$.

As was the case before, a linear regression was also run to arrive at a linear slope of best fit between students' spring and fall NWEA scores for each group as well as a coefficient of determination r^2 for each group. Figure 2 presents the scatter plot as well as the slope and coefficient of determination for each group's set of NWEA spring and fall NWEA scores. In each case, the relationship of spring and fall NWEA scores was significant (all online students ($r(91) = .85, p<.001$)); and not participating students ($r(65) = .84, p<.001$).

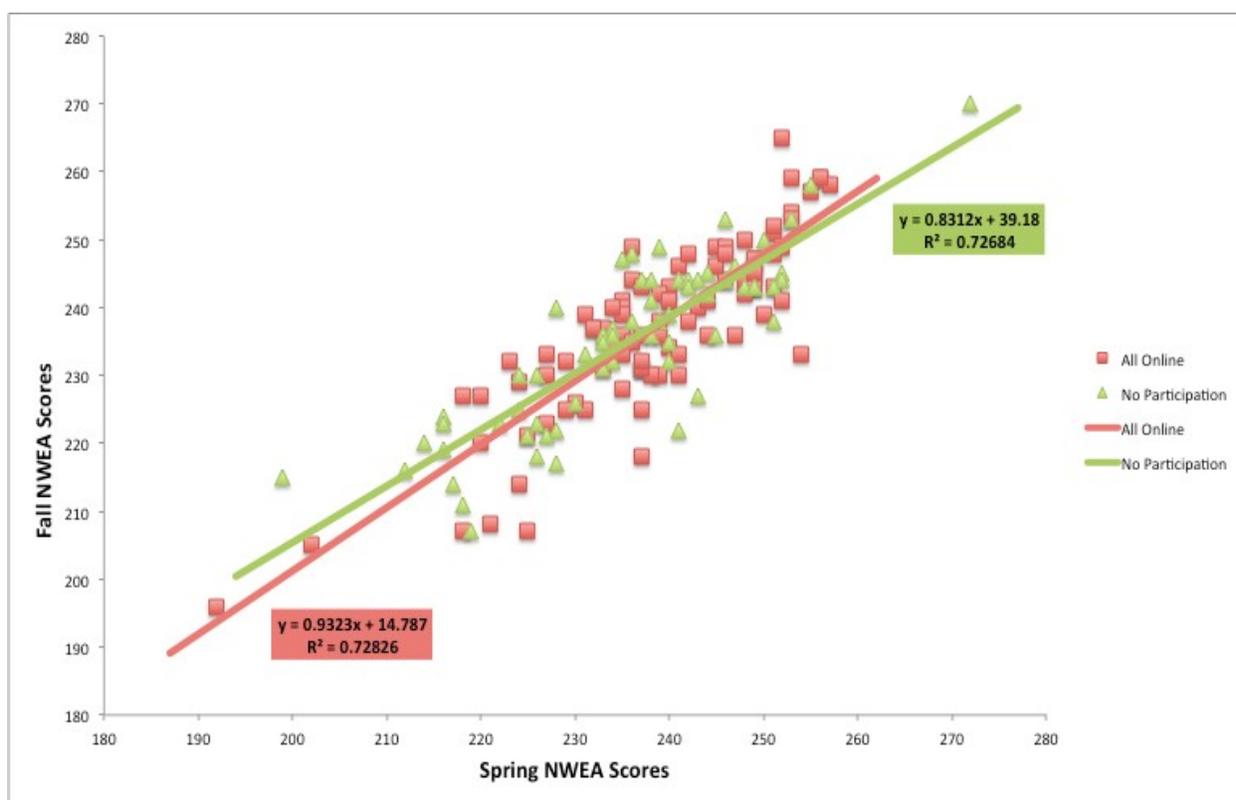


Figure 2. Spring and Fall NWEA Scores of Students who used Study Island and did not use Study Island over the Course of the Summer

Time. Given the results of these initial two ANCOVA analyses, it was decided to investigate if other factors may have impacted student NWEA scores. To determine whether there may have been a significant impact of amount of time spent on students' Fall NWEA scores, an

additional series of ANCOVAs considered the amount of time students spent on the online learning program to determine if students' NWEA math scores improved with the amount of time students spent working with the program. An ANCOVA was run comparing covariate gains between students who used the online math program 0-3 hours, 3-6 hours, or more than 6 hours against those students who did not use the program at all, with the assumption that students who spent more time on the program would evidence significantly greater NWEA scores than those students who did not use the program at all.

In none of these cases did an ANCOVA identify a significant difference in NWEA fall math scores, using students' spring scores as a covariate, in comparison to those students who did not use the program at all. There was no significant difference between those students using the program 0-3 hours ($n=38$) and those not using the program at all ($n=64$), $F(1,101)=0.03$; $p=.86$. There was no significant difference between those students using the program 3-6 hours ($n=28$) and those not using the program at all ($n=64$), $F(1,91)=1.74$; $p=.19$. And there was no significant difference between those students using the program more than 6 hours ($n=28$) and those not using the program at all ($n=64$), $F(1,88)=0.2$; $p=.66$. In addition to these analyses, as before, a scatter plot and best fit linear slope and coefficient of determination for each analysis is presented in Figures 3-5. In every case, the correlation between students' spring and fall NWEA scores was significant $p<.001$.

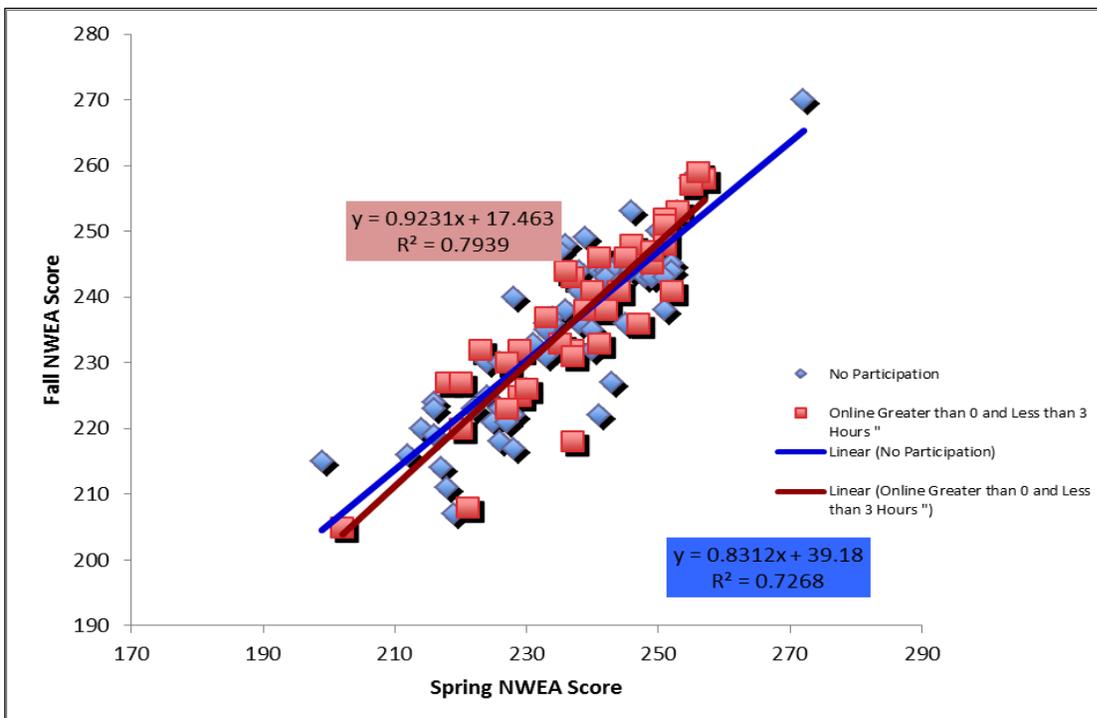


Figure 3. Spring and Fall NWEA Scores of Students Who Did Not Use Study Island Compared to Greater than 0 and Less Than 3 Hours of Use.

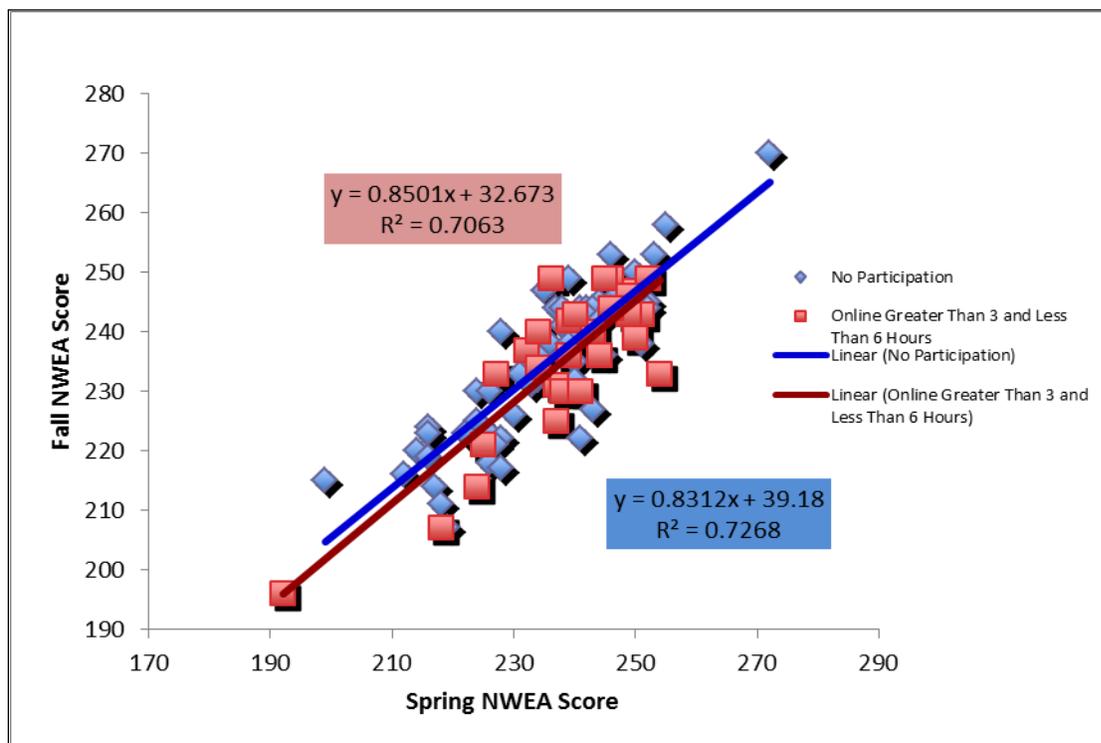


Figure 4. Comparison of Spring and Fall NWEA Scores of Students Who Did Not Participate Compared to Greater Than 3 and Less Than 6 Hours of Use.

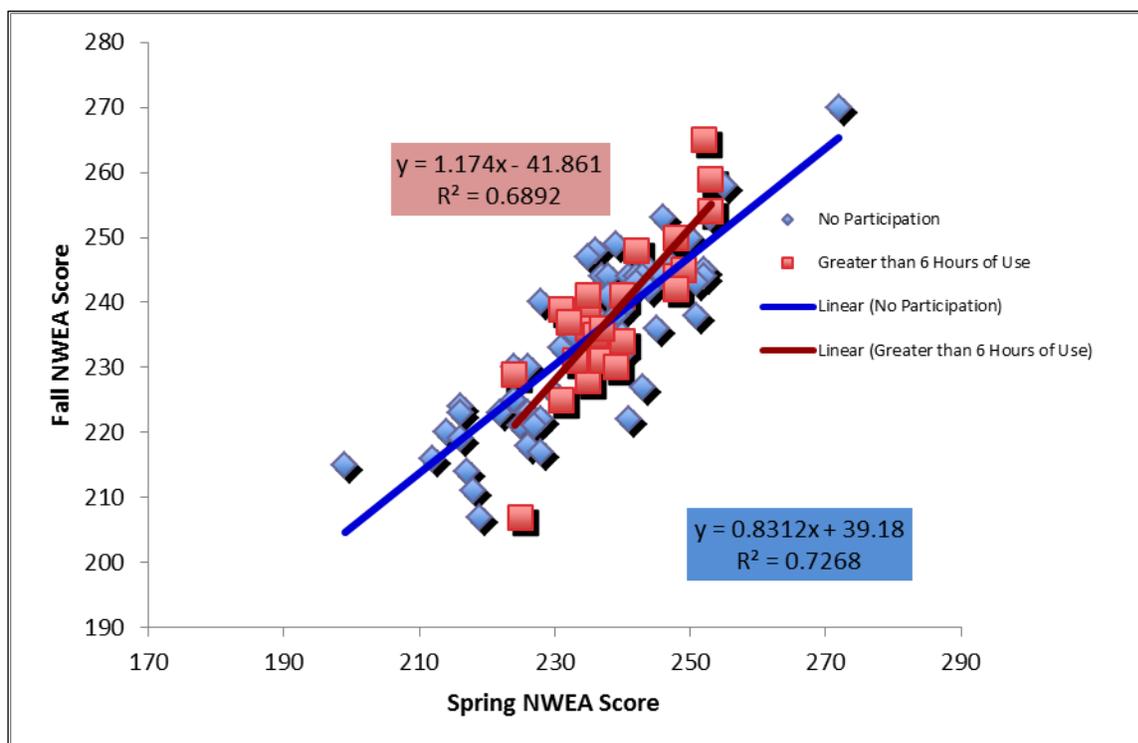


Figure 5. Spring and Fall NWEA Scores of Students Who Did Not Participate Compared to Students with More Than 6 Hours of Use.

Correlation between Ribbons earned and NWEA Gains. Within the Study Island program, participants can earn “blue ribbons” for their accomplishments. “Blue ribbons” are awarded to students who have mastered the material with at least at 70% threshold of success. In this case, the sequence of math content was according to the sequence as presented in Table 2.

Table 2

Sequence of Study Island Math Topics

Number Concepts	Pre-Algebra	Geometry	Algebra	Statistics
<ul style="list-style-type: none"> • Whole numbers • Functions with whole numbers • Estimation • Number theory • Fractions and decimals • Number lines • Percents • Absolute value • Order of operations 	<ul style="list-style-type: none"> • Rates, ratios and proportions • Exponent laws • Real numbers • Measurement • Unit conversions • Order of operations 	<ul style="list-style-type: none"> • Coordinate system • Parallel and perpendicular lines • Point, line, and plane • Polygons • Perimeter and area • Triangles • Pythagorean theorem • Surface area and volume 	<ul style="list-style-type: none"> • Translate expressions and equations • Variables • Formulas and inequalities • Quadratic equations • Functions • Functions with polynomials 	<ul style="list-style-type: none"> • Mean, median, mode • Plots& diagrams • Interpret graphs

Students who successfully completed deeper levels of the program according to the above sequence are typically evidenced by their obtaining more blue ribbons. For example, a student who had successfully completed all components of the program may have gained as many as 64 blue ribbons, while students who did not successfully complete any parts of the program would have gained no ribbons at all. Given this design, the question of whether students who gained more blue ribbons had greater gains in their spring to fall NWEA scores was considered. To determine if there was such a relationship, an additional analysis was undertaken.. To determine whether there was a significant relationship between NWEA gains and ribbons earned by students using Study Island, a Pearson product-moment correlation analysis was undertaken. The results of this analysis indicated no relationship between student spring to fall gains on their NWEA scores and the number of blue ribbons earned while utilizing the Study Island Math program ($r(91) = .39, p = .71$). A scatterplot of these values is presented in Figure 6.

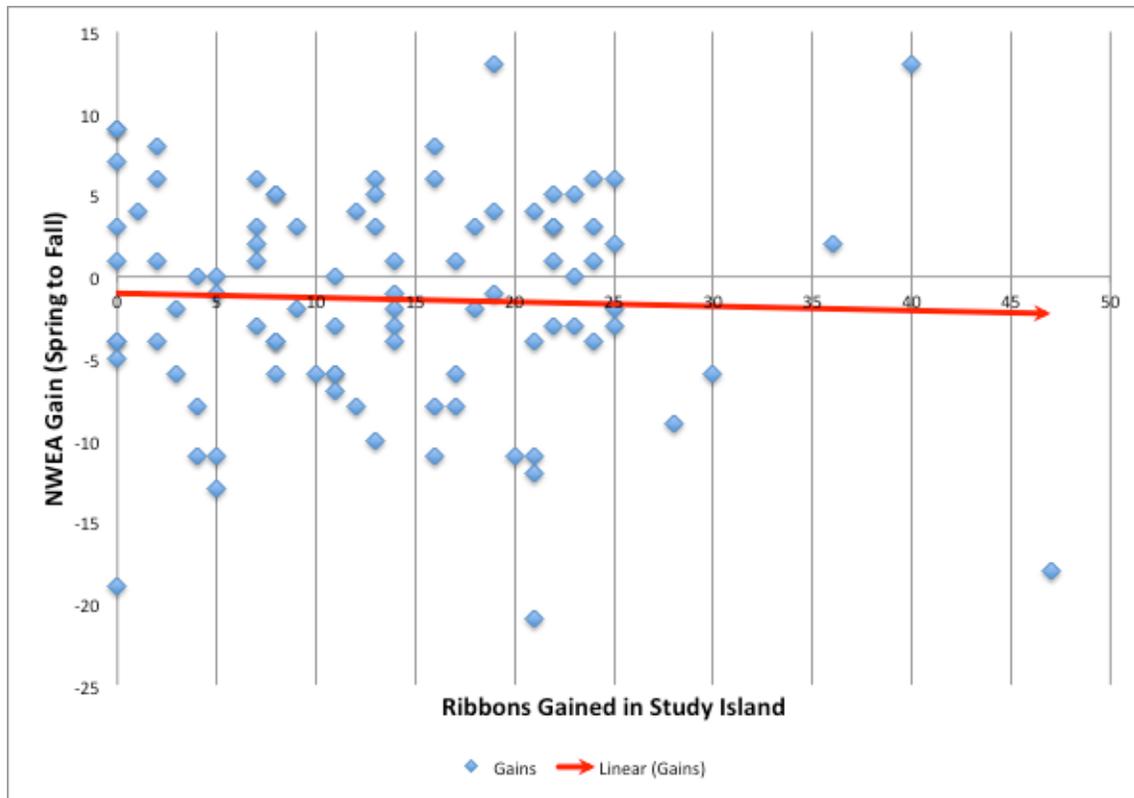


Figure 6. Correlation of NWEA Score Gains and Blue Ribbons Earned

Differences in students' final 9th grade math grades. Finally, as identified in administrators' interviews, the ultimate purpose of providing all 9th grade students with the opportunity to use the online math program over the summer was to enhance their readiness for 9th grade math classes. Given this expectation, 9th grade students' final math grades were analyzed to determine if one group of students – online only; online within the context of the hybrid classroom; or those with no participation at all – earned higher end of the year math grades. Clearly, a number of factors – internal and external to the student apply, for example, student motivation, teacher instruction, classroom support, and life circumstances – can significantly impact student's grades. However, given the administrators' explicitly stated hope that the online math program might increase students' readiness for their 9th grade math classes, it was

determined useful to analyze whether indeed there may be any indication that student use of the online program – independently or in the hybrid class – actually improved student readiness by way of their final 9th grade math grades.

Given this explicit expectation by administrators, all 9th grade students' final math grades were reviewed to determine if the students who participated in the hybrid class or use of the online program independently earned higher grades at the end of the school year. To account for variation across teachers in their individual grading criterion, however, groups of students were compared by classroom teacher only using a Mann-Whitney Test. The Mann-Whitney Test allows for a non-parametric analysis of significance between two groups according to their rank order of grades, and thus was used to compare the two groups by teacher. Six of the classes were compared as the remaining classes did not have enough students per group to create meaningful sample sizes for comparison. In only one case with one teacher was there enough hybrid students to validly use the test of significance against other groups. All other analyses were between students who used the online program independently and did not use the program at all. A minimum of 10 students were determined meaningful for the purpose of this test.

Student grades were coded as follows: A+ (1); A (2); A- (3); B+ (4); B (5); B- (6); C+ (7); C (8); C- (9); D+ (10); D (11); D- (12); and F (13). For descriptive purposes only, the mean and standard deviation for each group by classroom teacher was calculated for each of the 9th grade math classes by teacher. Table 3 shows the results of these calculations, as well as the average grade for that population of students. To test for differences between the two groups, a one-tailed Mann-Whitney test for non-parametric differences was used given the expectation that students using the online program would have been better prepared for 9th grade math. The Mann-Whitney U-value and one-tailed p-value is also included in Table 3.

Table 3

Mean End of Year Math Grades by Teacher Comparing Online Group with Hybrid Group

Teacher	N Online/ No Participation	Mean Grade / Std. Dev. Online	MeanGrade / Std. Dev. No Participation	Mann-Whitney U-value and p-value
Teacher #2	28 / 19	6.0 / 2.3: B-	7.9 / 3.0: C	364 p=.02*
Teacher #4	22 / 16	4.9 / 2.3: B	6.3 / 2.9: B-	228 p=.06
Teacher #5	24 / 19	7.5 / 2.6: C+/C	8.9 / 3.6: C-	298 p=.04*
Teacher #6	17 / 26	6.5 / 2.8: B-/C+	7.7 / 3.0: C	273 p=.10
Teacher #7	13 / 17	4.4 / 2.1: B+	5.1 / 2.6: B	126 p=.27
Teacher #8	19 / 22	4.8 / 2.1: B	6.0 / 2.5: B-	262 p=.09

Note: Std. Dev. = standard deviation

This analysis shows that students using the online program in the summer, on average, received a higher grade for each of the six teachers analyzed. This difference was only statistically significant using the Mann-Whitney non-parametric test with only two of the six teachers.

To ensure that this may not have been an artifact of students using the online program who had greater math skills than those not using the program prior to the summer and subsequent school year, as indicated by way of their spring NWEA test scores, a t-test of these scores between these two populations and across all teachers was undertaken. The result of this t-test indicated no difference in students' NWEA spring math scores between those students using the online program and those students not participating; $p > .05$. Online students' mean spring NWEA scores was 235.6 with a standard deviation of 14.1 (n=130) and not participating students' mean spring NWEA was 235.4 with a standard deviation of 12.8 (n=65).

Finally, teacher #8 was assigned to teach a greater number of hybrid participating students (11) than any of the other instructors. This created a sufficient number of hybrid students taught by one teacher to be statistically compared against the other two populations – those using the online program and no participation for purposes of this study.

As can be seen in Table 4, the hybrid students did not, on average, receive a higher grade than the non-participating students. This was confirmed using a Mann-Whitney test (one-tailed, $U=132.5$, $p=.33$). The hybrid students did not obtain a statistically significant higher grade than the online only students; in fact, using a one-tailed Mann-Whitney test, the hybrid students obtained a lower average grade than the online only students. This was significant using the Mann-Whitney test for the hybrid students in comparison to the online students ($U=147$, $p=.04$). To ensure that this may not have been an artifact of the hybrid students starting at a lower level of competence (or readiness for 9th grade math classes) compared to the online only students, a t-test of their spring NWEA test scores was conducted. Using a t-test, it was found that indeed the hybrid students scored significantly less than the online only students on their spring NWEA test. The spring NWEA scores for all hybrid students was 225.1 with a standard deviation of 16.6, which was significantly lower than the other two populations ($p<.001$; online mean = 235.6, st. dev. = 14.1; no participation mean = 235.4, st. dev. = 12.8). Thus, it was deemed inconclusive whether the online only students may have benefitted more from the program than the hybrid students at least as could be determined by their final math grades, as the two groups were not equivalent as determined by their spring NWEA test scores. The only conclusion that could be drawn is that the hybrid class did not significantly impact their NWEA grades above and beyond those of the online only students.

Table 4

Mean End of Year Math Grades by Group for Teacher # 8

Hybrid Avg. Grade Mean/St. Dev. N	Online Avg. Grade Mean /St. Dev. N	No Part. Avg. Grade Mean/St. Dev. N
B- 5.8/2.8 11	B 4.6/2.3 8	B- 5.7/2.7 22

Note: Avg. Grade = Average Grade; St. Dev. = Standard Deviation

Summary of NWEA data analysis. The statistical analyses above indicate that there is no statistically significant differences between the NWEA test score gains of the three groups of students – those who worked online independently, those who attended the summer hybrid class with use of the online program, and those who did not use the online program over the summer at all. However, when considered in the context of students' final 9th grade math grades, the data indicated that students using the online program over the summer received higher grades at the end of the school year than those students not using the program at all, and that this finding was statistically significant for two of the six teachers analyzed.

It is however, noteworthy that the students who participated in the hybrid summer class and were assigned to Teacher # 8 for the academic school year had lower end of the year math grades. It must be noted that these students were also identified as having a lesser proficiency in math according to their spring NWEA test results and their individual education plans which called for a full year school program, which resulted in their placement in the hybrid summer class. Therefore, their lower grades are in keeping with their identification as possessing lower math skills, with the hybrid class evidently not impacting their final math grades in 9th grade.

Finally, it is interesting to note as well that there were no significant findings regarding the amount of time students spent using the online math program or ribbons gained using the math program and any gains in their NWEA math scores from spring to fall. One might expect that more time spent using the program or more ribbons obtained using the math program – as an indication of success using the program – would have resulted in greater NWEA gains from spring to fall. This was not the case.

Benefits and challenges to this approach. One of the benefits to this secondary data review was that it provided an unbiased evaluation of the differing approaches to understanding the effectiveness of three different interventions: no participation; participation in a hybrid class; and independent use of the online program. The behaviors of each of the stakeholders – administrators, faculty, and students – were not influenced by prior knowledge of the research study. The NWEA testing is an online testing system designed to show individual student progress over time within the state frameworks. The NWEA testing provides information about a student's academic growth over time and is independent of grade level. The test is norm-referenced and provides information about how a student is performing and is used for placement purposes given that it provides an understanding of the level at which to begin instruction with each individual student.

One challenge of this research approach was the lack of complete data on all incoming 9th grade students. At times students did not complete both testing sessions, providing a smaller sample size than expected. Not all incoming 9th graders were tested in the spring for a number of reasons – they were admitted after the spring testing sessions; they were unavailable during the designated test times; or they made the decision to come into the school in the late summer or early fall. For purposes of this study it led to incomplete spring NWEA scores. Similar challenges

were evident in the fall testing sessions, with some students missing the testing sessions and while there was an effort made to reschedule, not all students were tested for a second time.

Another challenge of this approach to research was the novelty of the online learning environment for some of the students. While this study did not specifically investigate how many students had previously participated in an online learning program, it might have been helpful to understand how many students were familiar and comfortable with this approach to learning and assessment. This information could have provided more insight into this specific study and the students' experiences with online learning as well as the NWEA assessment tool.

Research Question #3: How did students perceive the online learning environment having assisted them in the development of their math skills over the summer and in preparing them for the upcoming school year?

Student surveys. A student survey was included in the fall testing session to gather qualitative data regarding summer learning experiences. Questions ranged from potential barriers to participation and student engagement to self-perceptions regarding students' math abilities to students' perceptions of whether the online program or hybrid class assisted them in their learning and prepared them for 9th grade. In total, 162 students completed the survey, 46 having completed the hybrid class and 116 having used the online program independently.

The survey tool was a simple Likert Scale questionnaire with several multiple choice questions. Appendices C and D provide copies of the surveys to hybrid class and online participants, respectively, as administered. Only students who participated in either the hybrid class or used the online program could contribute to the survey.

Below, the results of the surveys are reviewed for those students who participated in the hybrid class and those who used the online program only. Following those summaries is a

presentation of both the hybrid class and the independent online survey results with targeted comparisons made to compare the two groups of students.

Survey Results and Analysis for Students who Participated in Hybrid Summer Class.

Results of the student surveys completed by those who participated in the hybrid summer school class are represented in Tables 5-7. The responses were reviewed and quantified to gain an understanding of the students' perceptions and experiences with the summer school hybrid program which included an online component. The survey questions summarized on Table 5 utilize a Likert scale to determine degrees of agreement or disagreement with the statement provided, thus providing an understanding of the intensity of the feelings of the student respondents. The survey tool was designed to offer students the opportunity to anonymously share their experiences about the newly introduced summer mathematics program at VTHS. A summary of the student responses follows in the data tables.

Table 5*Hybrid Class Survey Results by Item*

	Strongly Disagree N %	Disagree N %	Agree N %	Strongly Agree N %
Attending Summer School Helped Improve My Math Skills	1 2.2%	7 15.2%	31 67.4%	7 15.2%
Learning Math in a Classroom with a Teacher Available to Help Me is Easier for Me Than Learning in Other Ways for example – homework, working by myself, etc.	1 2.2%	7 15.2%	30 65.2%	8 17.4%
My Teacher was Very Good at Helping Me in Math	2 4.3%	3 6.5%	32 69.6%	9 19.6%
I Think Summer School Prepared Me for 9 th Grade Math	2 4.3%	5 10.9%	33 71.7%	6 13%
I Would Attend Summer School Again if Possible	10 21.7%	16 34.8%	18 39.1%	2 4.3%

Note: N= 46 Students

Tables 6 and 7 summarize the survey questions which gathered student self-perceptions regarding their math abilities before and after participation in the newly introduced hybrid summer school math class. It is noteworthy that the survey tool allowed students to select two answers instead of just one, which accounts for the difference in total numbers of students answering these questions. In Table 6 two students gave duplicate replies and on Table 7 one student selected two answers confounding the data. Tables 6 and 7 follow.

Table 6

Hybrid Class Survey Question # 6: Before Summer School...

Answer Options	I Felt I was Really Good at Math	I Felt I was Ok at Math	I Felt I Was Not Really Good at Math
Responses	9	28	11
Percent	19.6%	60.9%	23.9%

Note: N=48, two students supplied duplicate answers.

Table 7

Hybrid Class Survey Question # 7: Did Summer School Help You Become More Confident in Your Math Abilities?

Answer Options	Yes	No
Responses	34	13
Percent	73.9%	28.3%

Note: N=47, one student supplied a duplicate answer.

Students who attended the hybrid summer school math program completed an online survey following their fall NWEA testing session. A total of 46 students completed this survey. Of those students, 82.6% agreed or strongly agreed with the following two statements: “Attending summer school at Southeastern helped improve my math skills” and “Learning math in a classroom with a teacher available to help me is easier for me than learning in other ways for example –homework, working by myself, etc.” suggesting that the students perceived a benefit from their hybrid summer school math class experience.

It is noteworthy that a majority of the students who attended the hybrid math class at VTHS felt they were “ok in math” prior to the class. See Table 6. Yet after attending the hybrid class, these students felt more confident in their math abilities. See Table 7. Additionally, of the students surveyed, 84.7%, agreed or strongly agreed with the statement: “I think summer school at

Southeastern prepared me for 9th grade math”, while 89.2% agreed or strongly agreed that “My teacher was very good at helping me in math.” See Table 5.

Survey results and analysis for students who used the online program independently.

Tables 8 summarizes the questions which utilize a Likert scale to determine degrees of agreement or disagreement with the statement provided, thus providing an understanding of the intensity of the feelings of the student respondents. As with the hybrid class survey, the survey tool for the students who used the online math program independently was designed to offer students the opportunity to anonymously share their experiences. A summary of the student responses follows in the data tables.

Table 8

Online Learning Survey Results by Items

Item	Strongly Disagree N %	Disagree N %	Agree N %	Strongly Agree N %
Online Learning this Summer Helped Improve my Math Skills	8 6.9%	27 23.3%	75 64.7%	6 5.2%
Learning Online was Easier than Learning in the Classroom During the School Year	22 19%	51 44%	34 29.3%	9 7.8%
I think the Online Class Prepared me for 9 th Grade Math	14 12.1%	28 24.1%	66 56.9%	8 6.9%
The Teacher Assigned to be my Online Mentor Helped Me Learn this Summer	20 17.2%	31 26.7%	59 50.9%	6 5.2%
I Would Take Another Online Class if I Could	39 33.6%	40 34.5%	32 27.6%	5 4.3%

Note: N = 116 Students

Table 9

Online Learning Survey Question # 5: Most of the Time for Online Learning I Used the Computer at:

Answer Options	Home	Library	Friend's House	School
Responses	111	1	1	3
Percent	95.7%	0.9%	0.9%	2.6%

Note: N = 116 Students

Questions #8 and #9 asked about confidence levels and how student's working online independently felt about their math skills. Results are displayed on Tables 10 and 11.

Table 10

Online Learning Survey Question #8: Before my Online Class I felt...

Answer Options	I Felt I was Pretty Good at Math	I Felt I was Ok at Math	I Felt I was Not Really Good at Math
Responses	61	47	8
Percent	52.6%	40.5%	6.9%

Note: N= 116 Students

Table 11

Online Learning Survey Question # 9: Did Online Learning Help You Become More Confident in Your Math Abilities?

Answer Options	Yes	No
Responses	62	53
Percent	53.9%	46.1%

Note: N= 116 Students

Both administrators at interview identified a potential barrier to accessing the newly implemented summer school math program independently. This perceived barrier of access to computers was identified by both administrators, however, according to the survey results, 95.7%

of the students having access to a computer at home with only 3 students (2.6%) having to come into VTHS to use the school's computers. See Table 9.

With regard to student self-perceptions of their math abilities, 69.9% either agreed or strongly agreed with the statement: "Online learning this summer helped improve my math skills." See Table 8. Additionally 63.8% agreed or strongly agreed with the statement: "I think the online class prepared me for 9th grade math." See Table 8.

Conversely, 63% of the students who worked independently online strongly disagreed or disagreed with the statement: "Learning online was easier than learning in the classroom during the school year." See Table 8. Of this group of independent online users, 68.1 % strongly disagreed or disagreed with the statement: "I would take another online class if I could." See Table 8.

Survey results for the students who worked online independently suggest that while they participated as assigned during the summer, the majority would not take another online course given the choice and that they perceived learning in a classroom during the school year to be an easier learning environment for them.

Comparing Survey Results – Independent Online Learning Group and Hybrid Summer School Class. The results of the student surveys for both groups of students – hybrid and online students responses regarding their math abilities before beginning the summer math program were compared. Figure 7 represents the differences between the two groups.

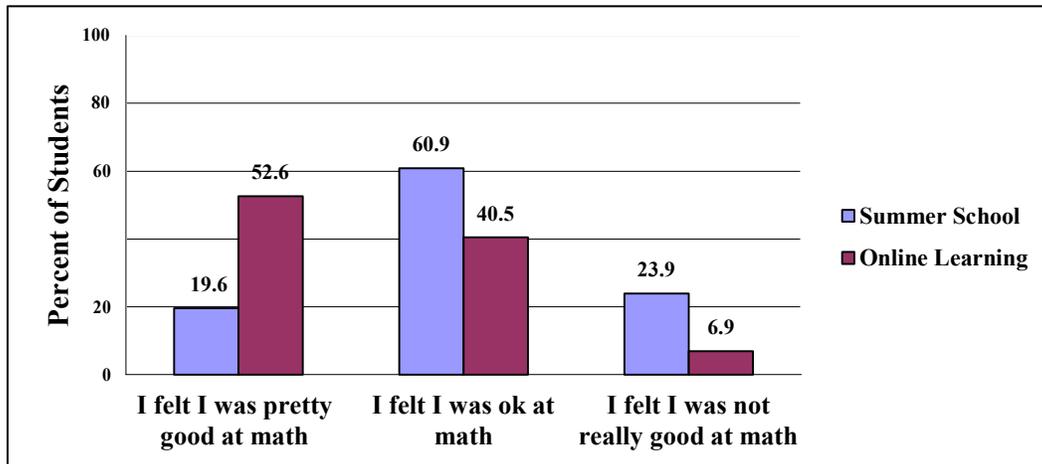


Figure 7. Online and Summer School Hybrid Students Perceptions of their Math Abilities before Participation in Summer Learning Program

This comparison suggests students who attended the hybrid class during the summer had a higher confidence in their own abilities than was evidenced in the NWEA scores. Student surveys also showed a difference in confidence levels following participation in the new summer math program. See Figure 8 for comparison of student responses to the survey question “Did summer school help you become more confident in your math abilities?” Again, the students who attended the hybrid class were more confident in their math skills following the summer math program than the students who participated in the online learning program.

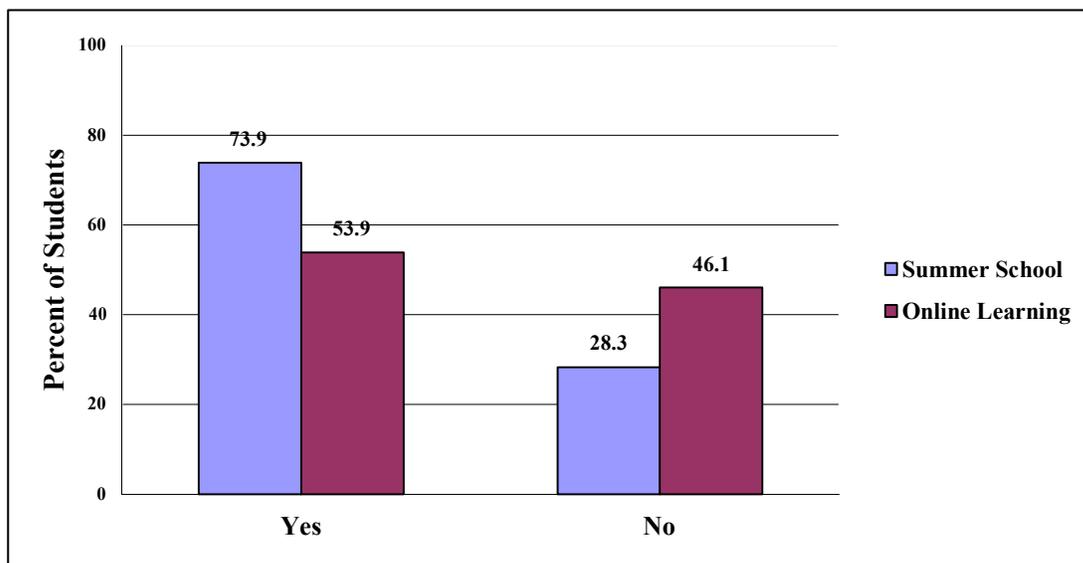


Figure 8. Comparison of Student Confidence in Math Abilities After Summer Program

Summary of survey data. The survey data suggests that the students felt they were appropriately placed for their summer learning opportunities, however, had mixed feelings about their experiences. The majority of online students surveyed felt the online environment was helpful to their math skills and in preparing them for 9th grade math but did not think that taking an online class was easier than learning math in a traditional classroom setting and would not opt to take another online course if given the opportunity.

The students who attended the hybrid summer school class with an online learning component were overall positive about their experiences and they felt well prepared for 9th grade math as a result of their summer school experiences.

Student survey results suggest the students who were assigned to the hybrid group had a higher confidence in their math abilities entering the summer math program than those assigned to work online independently. When comparing the answers to the question surrounding their confidence levels after participating in the summer math program, again, the students assigned to

the hybrid class were more confident in their abilities than the students assigned to work independently online.

Benefits and challenges to this approach. The surveys provided students with an opportunity to anonymously provide their perspectives on their summer math experiences. Surveys also provided specific information regarding student confidence in their abilities and beliefs about preparation for the upcoming school year. The surveys were limited in that there was no opportunity to follow up with the students on the answers provided to gain a deeper understanding of students' motivations, experiences, and understandings of the online learning experience, however, overall did provide meaningful insights into the student experience with the newly implemented summer school math program at VTHS.

Student focus groups. It was hoped to further deepen the understanding of student experiences with regard to the new summer math initiative by gathering focus groups prior to the end of the school year. Unfortunately, due to the logistics of scheduling these meetings at the end of the school year, no focus groups were able to be held. Future research efforts might benefit from incorporating this direct conversation method of gathering data, however, for purposes of this study that perspective was unavailable.

Chapter 5: Discussion of Findings – Implications for Educational Practice

This study was designed to determine if an online learning environment improved mathematics proficiency in incoming 9th grade students at a vocational technical high school in Massachusetts as measured by a comparison of spring and fall NWEA testing and student math grades at completion of their freshman year. It compared three different groups of students: (1) students who did not use the online program; (2) students who used the online program independently; and (3) students who used the online program with support of an instructor in a

hybrid summer math class.

The following research questions were addressed in this study:

1. What were the expected outcomes of a vocational technical high school administration with regards to online math instruction for incoming 9th graders?
2. How did use of an online learning environment effect students' math skills when used independently and in a hybrid math class over the summer?
3. How did students perceive the online learning environment having assisted them in the development of their math skills over the summer and in preparing them for the upcoming school year?

After a comprehensive literature review, identification of theoretical frameworks, selection of a research approach, design and analysis of data collected through a secondary data review, personal interviews and student surveys, an interpretation of the results of this study follows. This chapter will summarize the research findings in the context of the theoretical frameworks of sociocultural learning and online learning theory and a review of the current literature.

The following hypotheses were considered:

Hypothesis 1: Students who independently used the online learning math program will evidence significantly greater gains in their NWEA math scores from spring to fall than those students who did not use the online math program.

Hypothesis 2: Students who participated in the hybrid math summer school class, which included use of the online math program, will evidence significantly greater gains in their NWEA math scores from spring to fall than students who did not use the program as well as those students who used the program independently.

Review of Methodology

This research is a mixed-methods outcomes study, investigating whether students' math skills improved based on their use of an online learning program independently or within the context of a hybrid summer school class. The site of this research, is a midsized regional vocational technical high school in Massachusetts (VTHS) which serves nine communities.

The administrators and the hybrid summer school instructor at VTHS were interviewed to ascertain their expectations for the newly introduced math program. These interviews were reviewed and common themes were identified and reported.

This outcome study also employed a quantitative analysis of math gains as measured by changes in NWEA assessments from spring to fall test administrations and between three student groups: (1) students who did not use the online math program; (2) students who independently used the program; and (3) students who used the online program in the context of a hybrid summer math class.

Finally, the study also included an analysis of a student survey administered to assess the degree to which participating students felt the online learning program or the hybrid class improved their math skills and prepared them for 9th grade math. The students' final math grades were also analyzed to determine if there were statistically significant differences between the groups.

Summary of Findings

This researcher interviewed two administrators and the hybrid summer school math instructor to gain their perspectives on the newly introduced summer school math initiative. The administrators' goals for the program were partially met given that the incoming 9th grade class was introduced to an online math program that could help students begin to take responsibility for

their own learning and those that participated were introduced to a web-based learning environment. The initiative was less successful with engaging all students in the program; identifying student abilities and learning styles; and insuring that student's entered the school working at grade level in mathematics. The study was not designed to investigate all aspects of the summer math initiative identified by the administration as important. Student learning styles were not identified and their math skills were not measured in the context of their grade level, thus no comment can be made regarding these aspects of the new program.

Next a secondary data review of NWEA test scores from the spring and fall 2010 was conducted with numerous statistical analyses administered. A total of 155 students completed both the spring and fall administrations of the NWEA testing sessions and thus were incorporated into this research study. Within this group, 15 of the students had participated in the summer hybrid program, 76 worked online independently and, from a review of online learning program data, 64 were identified as not having engaged in any summer math learning at all. Amongst the three groups studied (1) students who did not use the online program; (2) students who used the online program independently; and (3) students who used the online program with support of an instructor in a hybrid summer math class, there was no statistical significance to the gains in NWEA math scores when comparing their pre- and post-summer school math initiative participation.

Given the lack of statistical significance between the three groups, another ANCOVA analysis was administered combining the hybrid class students with the students who worked online independently versus those who had not worked at all. Again, no statistical significance was found between the two groups.

Several ANCOVA analyses were conducted comparing the students who used the online

learning program greater than 0 and less than 3 hours versus the students who did not use the program at all; students who used the online learning program greater than 3 hours and less than 6 hours versus the students who did not use the program at all; and those that used the online learning program more than 6 hours versus the students who did not use the program at all. No statistically significant difference was found in any of the three groups studied.

A different approach was then considered. The online learning program participants could earn “blue ribbons” when they reached a 70% threshold of success in a section of the program. It was decided to determine whether the students who earned more blue ribbons had greater math gains as measured by pre- and post-NWEA test scores. This analysis showed no significant relationship between numbers of blue ribbons earned and improved math scores.

Once again, a different perspective was considered. Did the students with the highest number of blue ribbons gain them because they already had mastered the necessary math skills prior to participating in the online learning program? The students who scored lower than 240 on their spring NWEA test were considered to see if they had greater gains than the other students. The students who scored the lowest on their spring NWEA test were divided into two groups – the hybrid class and the online independently groups. An ANCOVA analysis was again utilized and there was no statistically significant findings as a result.

Because of the limited information gained from the ANCOVA analyses of the NWEA math scores comparing the students in their various groups, it was decided to compare the final grades earned by the three groups of students in their 9th grade math classes with their NWEA test scores. In this case a statistical significance was discovered between the online and the hybrid class of students studied. The students who attended the hybrid summer math class had lower end of the year math grades than those who worked online independently. It is noteworthy that the

students who were assigned to the summer hybrid classroom, did earn lower grades at the end of the year in their math classes than their online peers, however, this might be attributed to the lesser math proficiency which they began with.

Student surveys were collected following the fall NWEA test session to gather student perspectives on their experiences in the new summer math program. Following an analysis of these surveys, the findings suggest that both groups of students (those who attended the hybrid summer school math program and those who worked independently online) were more confident in their math skills following participation in the program. Additionally, the majority of the students who worked online independently did not enjoy this approach to learning when compared to a traditional classroom setting and if given the opportunity would not take another online class. Given that the online learning phenomenon is rapidly spreading through the K-12 public school system, it would be prudent to understand the perspectives of the various stakeholders not only via surveys but other formal and informal means of gathering data as well.

Discussion of Findings in Relation to the Literature Review

Online learning. According to a meta-analysis conducted in 2009, for the U.S. Department of Education report by Means et al. (2009), comparing online learning versus face-to-face instruction, only five controlled studies were found in the K-12 educational arena. The report concludes “educators making decisions about online learning need rigorous research examining the effectiveness of online learning for different types of students and subject matter as well as studies of the relative effectiveness of different online learning practices” (Means, et al., 2009, p. 54). The study conducted at VTHS suggests that incoming 9th grade student’s participation in an online learning math program either independently or in the context of a hybrid summer school class did not guarantee improved student proficiency in math. There was no statistical difference

when comparing the gains in NWEA math scores pre- and post-participation in the online learning program between the three different groups of students: (1) students who did not use the online program; (2) students who used the online program independently; and (3) students who used the online program with support of an instructor in a hybrid summer math class. This finding is in keeping with Means et al. (2009) call for more research on the effectiveness of online learning programs and identification of which learning styles are best suited for this approach to education. Despite the proliferation of online learning programs, to date limited research has been conducted to evaluate their merits and determine the best practices of this new form of learning. In addition, despite an extensive literature search, not one study was found that investigated the online learning experiences of vocational technical high school students.

Growth of online learning. According to Zanberg & Lewis (2008), “In 2004-05 there were an estimated 506,950 technology-based distance education course enrollments in public school districts” (p. iv). A more recent study by Cavanaugh (2009) found “the number of elementary and secondary students taking online course increased tenfold between 2001 and 2007, from about 200,000 to almost 2 million, and could easily reach several million by 2012” (p. 2).

Despite this proliferation of online learners in the United States, there is confusing and conflicting research with regard to best practices and student benefits of this approach to learning and teaching. Lips (2010) in a Heritage Foundation funded study found “Students appear to be benefiting from online learning programs. A meta-analysis of empirical evidence on line learning programs found that students learn as well or better on line as in a traditional school setting” (p. 10). Additionally, the U.S. Department of Education meta-analysis conducted by Means et al. (2009) discovered that “Instruction combining online and face-to-face elements had a larger advantage relative to purely face to face instruction than did purely online instruction” (p. xv).

The study of students who participated in the newly introduced summer math initiative at VTHS conflicts with both Lips' 2010 report and Means et al. 2009 report in that students did not improve their math proficiency as measured by NWEA testing pre- and post-participation in either independent online learning or within the context of a hybrid summer school class.

Based on the literature search, this researcher hypothesized that students who participated in an online learning program in the context of a hybrid classroom would improve their math proficiency more than those who worked independently with the same online learning program. It was further hypothesized that students who participated online would improve their math skills more than those who did not participate at all.

Neither of these hypotheses proved true in this study of vocational technical high school students which suggests that future research should control for other variables that potentially impact student learning. Consideration in future research might be given to identifying student learning styles as well as potential social, emotional and behavioral challenges that may create barriers to participation, learning and ultimately success.

Online learning in secondary schools. Kay and Knaack's 2008 study of the effectiveness of learning objects (interactive web-based tools) in the secondary classrooms found that "students who were more comfortable about computers, appreciated learning objects more than their less confident peers, however performance was unaffected" (p. 1304). This study supports the findings of the VTHS research project which also found that student participation or non-participation with an online learning program itself did not impact math proficiency as measured by fall NWEA test scores. No investigation of comfort levels with computers was included in this study, however, the hybrid class instructor did note that he had to teach the students how to access the online math program.

Learning mathematics online. A 2008 study by Tienken & Maher found when investigating the influence of computer-assisted instruction (CAI) on eight grade mathematics achievement, found “the results suggest that the CAI intervention did not improve student achievement significantly ($p > .05$). In two categories, students who received the CAI performed significantly lower than their peers in the comparison group” (p.1). The authors further found that “the CAI program may have a negative influence on some of the district’s academically weakest students” (p. 12).

Alternately, Hannafin & Foshay found in their 2008 study that computer based instructional course (CBI) when used as a remediation strategy for students at risk of failing the mathematics portion of the Massachusetts Comprehensive Assessment System (MCAS) improved student success. This study found that “overall scores of all 10th graders increased significantly compared to their 8th grade scores, students who participated in CBI course improved more than the students who did not” (Hannafin & Foshay, 2008, p. 147).

These studies and other studies have returned equally conflicting results with regard to learning mathematics online versus in a traditional classroom. While the research conducted on the newly introduced summer math program at VTHS showed neither a negative nor a positive influence on student math proficiency, it did investigate a previously unstudied group of vocational technical high school students making it unique amongst the other studies which investigated learning mathematics online.

Other online learning considerations. When interviewed, the principal identified one of his priorities as having students take responsibility for their own learning via the newly introduced online learning program. This goal was only partially met because not all incoming 9th grade students participated in the assigned summer math program, however the goal is supported by the

2006 research study by Richardson and Newby. In that study, Richardson and Newby found “that as students gain experience with online learning, they come to take more responsibility for their own learning”(p. 23). While not specifically measured in this study a follow up of the three groups of students might yield data to support this claim of increased responsibility for their own learning.

Another consideration for online learning environments is that there remains a digital divide in this country which does not allow for equal access to technology for all students outside of the school building. Collins and Halverson (2009) point out that “technologies that seem to create more opportunities of equity in learning may well serve to reinforce the widening economic gap. The challenge of technology-driven learning opportunities rests on the questions of access...The different access in homes limits the abilities of schools to equitably distribute access to new learning technologies” (p. 7).

Further investigation is necessary to determine if this is also true for VTHS students, while 97.5% of the students in this research study reported access to computers outside of the school, there were another 130 students who did not participate in the online math initiative during the summer of 2010 yet did complete the fall NWEA testing session. For this group of students, their ability to access computers and an online learning program was not determined.

Barbour and Reeves in a 2008 review of virtual schools found that

Presently, the vast majority of virtual school students tended to be a select group of academically capable, motivated, independent learners. The benefits associated with virtual schooling are expanding educational access, providing high-quality learning opportunities, improving student outcomes and skills, allowing for educational choice, and achieving administrative efficiency. However, the research to support these conjectures is

limited at best. The challenges associated with virtual schooling include the conclusion that the only students typically successful in online learning environments are those who have independent orientations towards learning, highly motivated by intrinsic sources, and have strong time management, literacy, and technology skills. These characteristics are typically associated with adult learners. (p. 402)

The interview with the hybrid summer school math teacher was in keeping with the 2008 findings of Barbour and Reeves. He identified students needed assistance with managing their time online. Some of the students enjoyed the games associated with the online learning program so much that they needed prompting to move along and stop playing the games. One student did not move past basic addition problems because he enjoyed playing the games so much. Others were so distracted during the daily math lecture that the instructor had to block the computers to force the students to pay attention. In addition, the instructor also indicated that the students struggled with the technology and he needed to provide instruction in the use of the computers and the online learning program as the “Help menu” was not very effective for the students. (B. Clifton, personal communication, June 13, 2011)

Discussions of Findings in Relation to Theoretical Framework

Sociocultural learning theory. American culture is infused with technologies which today’s high school students generally embrace with enthusiasm. Computers, cellphones, video gaming systems and other forms of technology are an integral part of adults’ and children’s lives today. Many schools have begun to introduce various technologies to the academic environment in an effort to engage students and enhance learning opportunities. As Miller (2002) points out culture is defined as “shared beliefs, values, knowledge skills, structural relationships, ways of doing things (customs), socialization practices and symbol systems” (p. 374). American society

is currently undergoing dramatic cultural shifts given the seemingly never ending creation of newer, cheaper and widely available technologies. Public schools today can select from a vast collection of online learning programs and a variety of new technologies for the classroom as a result of this explosion of educational technology and software programs.

This study looked at VTHS, a vocational technical high school, which created a new summer program to help incoming 9th grade students improve their math skills. Of the students who participated in this new summer math initiative and worked online independently, 69.9% reported on follow up surveys that they either agreed or strongly agreed with the statement: “Online learning this summer helped improve my math skills.” Additionally, 63.8% agreed or strongly agreed with the statement: “I think the online class prepared me for 9th grade math.” However, 63% of the students who worked independently online strongly disagreed or disagreed with the statement “Learning online was easier than learning in the classroom during the school year” and 68.1 % strongly disagreed or disagreed with the statement “I would take another online class if I could.” This suggests that while the online learning group believed that the summer math program helped their math skills, the majority did not find it easier to learn in this manner and were not interested in taking another online course.

These findings suggest that while students may be embracing technologies outside the classroom, more than 60% of these incoming 9th grade vocational technical students did not find this approach to learning math easier than a traditional classroom setting and would not take another online course if given the opportunity. This might be one of the reasons for the lack of compliance with the school’s requested three hours per week of online participation during the summer. Not one student in the online group reached the expected 18 hours of participation set by the school.

In 1915 John Dewey (1915) wrote in his essay, *The School and Social Progress* (1915): “The modification going on in the method and curriculum of education is as much a product of the changed social situation, and as much an effort to meet the needs of the new society that is forming, as are changes in modes of industry and commerce” (p. 6).

Dewey’s words are as relevant today as they were almost a century ago. Educating students in the current technologically infused American culture is an ongoing challenge as schools and educators attempt to keep up with the fast paced evolution of technology and society. This research project directly investigated the cultural shift towards online learning and away from the traditional face-to-face classroom instruction. The findings of this study provide a deeper understanding on the effectiveness of one mathematics initiative implemented for a specific group of learners – the vocational technical high school student.

In this study, no statistically significant improvement in mathematics skills was found when measured by the NWEA test and end of year math grades for students who either participated in the hybrid summer school class or those who utilized the online learning environment independently was found to be inconclusive. However, given the evolution of American society, VTHS’s introduction of an online summer mathematics program should be considered a positive step in developing a curriculum that reflects the realities of the society that students will eventually be joining following the completion of their formal education. More research is necessary to determine the reasons for the lack of improvement in student NWEA math scores and the characteristics of students who most benefit from this approach to learning.

Online learning theory. Within the context of online learning theory, the findings of this study were in keeping with Anderson’s (2010) report that “the challenge for teachers and course developers working in an online learning contexts, therefore is to construct a learning environment

that is simultaneously learner-centred, content-centred, community-centred, and assessment-centred. There is no single best media of online learning nor is there a formulaic specification that dictates the type of interaction most conducive to learning in all domains and with all learners” (p. 66). The students in this study are a group of learners who voluntarily apply to attend a vocational technical high school with its curriculum of alternating academic and vocational classes. The vocational classes are held in shops that attempt to replicate a real work environment with the necessary tools, supplies and employee interaction opportunities. During their vocational cycle, students are given the opportunity to interact with each other and customers in a manner they will assume when they enter the workforce. While not directly investigated, it is presumed that this group of students have multiple learning styles which are best served by the hands on approach to learning within the more practical environment a vocational technical high school offers. As the hybrid math instructor pointed out the “students were bored to death with no hands on projects” (B. Clifton, personal communication, June 13, 2011).

This study investigated an online learning program that did not incorporate any hands on learning opportunities or group activities and which may have resulted in less successful gains in math scores as measured by NWEA testing.

While it was outside the scope of this study to investigate the reasons for non-participation and potential dissatisfaction with the new summer initiative, the general findings supported the research of Miller and King (2003) when they found that there are a “number of factors that contribute to course non-completion in distance education: lack of feedback; feelings of isolation; frustrations with the technology; anxiety; and confusion” (p. 286). The students in the hybrid class were observed by the instructor to require specific instruction in the use of technologies to avoid frustration as the online help menu was not very useful to the students. (B. Clifton, personal

communication, June 13, 2011) The group of students that did not participate at all in the summer math initiative, despite being offered a positive reward as a motivator, may have experienced some of the challenges outlined above, however, further research would be necessary to investigate the psychological, emotional and behavioral barriers to their participation in this new summer math initiative.

According to Cavanaugh (2009),

A school that chooses distance education to expand the school day or year should consider individualized curricula and instruction. Instructional methods and materials in online courses must be designed and sequenced to suit students' unique developmental levels. Younger learners and those with a weaker academic foundation need more adult facilitation, smaller lesson chunks, fewer choices in their coursework, more explicit instructions, more assistance with organizing their efforts and materials, and access to a wider range of tutorial and help applications. (p. 9)

The incoming 9th grade class of students studied exhibit some of the characteristics described. They were younger learners, some with less academic skills as measured by spring NWEA testing and require more adult facilitation, explicit instruction and assistance in managing themselves in an online learning environment, according to the summer school math instructor interviewed for this study (B. Clifton, personal communication, June 13, 2011).

One of the goals outlined by one of the administrators was to identify student abilities and differentiate accordingly. The summer school instructor suggested that leveling might make the hybrid class more successful as some students "couldn't add and others were doing geometry" (B. Clifton, personal communication, June 13, 2011). He further stated that he "prepared lessons and taught for 15 to 25 minutes depending on the lesson...I think that with math it is necessary to

have it taught live [rather] than reading it off the screen” (B. Clifton, personal communication, June 13, 2011).

The group of students assigned to the online summer program by VTHS, while being provided with an adult mentor, did not have access to the individualized support or instruction which may have impacted their participation and ultimately the outcomes of this study.

Future investigations might include a component to more clearly understand the reasons for non-participation. In this study, 64 students who completed both the spring and fall NWEA testing sessions did not participate at all, despite having the opportunity; the potential reward of selecting an elective class rather than being assigned to an academic support class in the fall; and mentor support throughout the summer. Additionally, another 130 students in the incoming 9th grade class did not participate in the summer math initiative. Thus, a total of 194 students of the incoming 9th grade class of 322 students did not participate. Further investigation could potentially identify the barriers to participation and provide a deeper understanding of the incoming 9th grade student experience with regard to opportunities to learn online.

Summary Review of Findings in Relationship to the Theoretical Frameworks

Despite the lack of statistically significant findings with regard to improved math scores, the summer math initiative implemented during the summer of 2010 at VTHS can be considered successful within the context of both sociocultural and online learning theoretical frameworks. The administration’s decision to enroll every incoming 9th grade student in either the hybrid summer class or to work online independently is in keeping with both the online learning and the sociocultural theoretical frameworks which connect education to the greater society in which the student lives and will eventually work.

Computers and technology are an integral part of American society and the workplace and

will continue to evolve in the education setting as well. Thus the principal's decision to ask every incoming student to participate in an online learning program yielded ancillary benefits not considered in the study but outlined in both theoretical frameworks. Students became familiar with the software and computer technologies through exposure and practice using them. These skills will continue to be used throughout their high school years at VTHS and most likely in their workplace after completion of their education. Students were expected to learn how to use the software under the guidance of a mentor or hybrid class instructor and be responsible for managing their own time on learning. This is similar to the greater society, where employees receive guidance from supervisors but then are generally expected to have the skills to work independently on the projects assigned to them.

Limitations of the Study

Despite the many findings of this research, the following should be considered limitations of the study and considered in future research efforts:

- The experiences of all the students in the incoming 9th grade class were not captured in this research because of number of students that did not complete both spring and fall NWEA testing sessions. Less than one half of the students' scores could be used for statistical analysis because of missing NWEA test scores.
- The NWEA assessment tool was developed by a for-profit educational testing company without independent research supporting the validity reported by the company.
- The instructor for the summer school hybrid class was not licensed as a high school math teacher. He does have a Ph.D. in the social sciences and was employed as a history teacher during the 2010-11 school year.

- While it is hoped that the students responded honestly to questions on the survey, depending on how they felt about the program or summer school in general, they may not have been forthright in their answers.
- On the survey questions that did not incorporate a Likert Scale, students were allowed to select more than one answer which created a situation where students may have selected two answers. This occurred in question numbers 6 and 7 for the students who attended the hybrid class and resulted in 48 responses for question 6 and 47 responses for question 7 despite only 46 students having completed the survey.
- Initial testing in Spring 2010 was completed in small groups of students while Fall 2010 testing occurred during a study hall period with many more students present, thus creating different testing environments for each session.
- This research was conducted in a school with many forms of technology available to faculty and students. The ability to utilize these technologies throughout the day along with Wi-Fi access throughout the building and grounds created a potentially unique school environment. These resources may make it difficult to replicate this study in a district with less available technology and with faculty less proficient in its use.
- Student focus groups could not be conducted due to final exams, transportation issues and difficulty scheduling students at the end of the year, thereby eliminating the opportunity for follow up questions with regard to student beliefs and behaviors.

Conclusion

This mixed methods outcomes study to determine if a newly introduced online learning program improved student math proficiency in an incoming 9th grade class at a vocational technical high school realized the following:

- The school administrators interviewed found the newly introduced online learning program to be successful with limited need for adjustments in upcoming year.
- The math instructor's perspective of the newly introduced online learning program was that most students struggled with the technological needs of the online learning program. This points out the need for explicit computer instruction prior to implementation of this program.
- The math instructor observed that students of this vocational technical high school had difficulty managing the online approach to curriculum delivery and the limited hands on learning and project based learning opportunities offered in the hybrid summer classroom.
- Comparison of spring and fall NWEA scores of students who did not use the Study Island online math program and those who used it independently or as part of a hybrid class were not found to be statistically significant when ANCOVA analysis was administered.
- Spring and fall NWEA scores for students who used Study Island and those who did not use Study Island over the course of the summer were compared using an ANCOVA analysis. There was no statistically significant difference between the two groups.
- Spring and fall NWEA scores of students who did not use Study Island compared to greater than 0 and less than 3 hours of use were analyzed using ANCOVA and no statistically significant difference was found.
- Comparison of spring and fall NWEA scores of students who did not participate compared to greater than 3 and less than 6 hours of use were analyzed and found to have no statistically significant difference between the groups.

- Spring and fall NWEA scores of students who did not participate were compared to students with more than 6 hours of use using an ANCOVA analysis. No statistically significant difference was found between the groups.
- NWEA score gains in comparison to blue ribbons earned was investigated with no significant findings found. There does not appear to be a correlation between the number of blue ribbons students earned and an increase in their NWEA scores.
- Students participating in both the online learning environment via either a hybrid class setting or independently outside of summer school felt the online math program to be helpful in improving their math skills, however, given the choice 68.1 % of the independent online users strongly disagreed or disagreed with the statement: “I would take another online class if I could”
- Students attending the hybrid summer school class agreed or strongly agreed with the following statement: “Learning math in a classroom with a teacher available to help me is easier for me than learning in other ways (for example- homework, working by myself, etc.)” 82.6% of the time.
- Further research of teacher satisfaction and motivation in the hybrid classroom is warranted given the hybrid instructors’ experience teaching the class and his observations on the lack of professional challenge with this approach to mathematics instruction.
- Analysis of the students final math grades showed no statistically significant relationship between end of year math grades and participation in any of the three student groups - (1) students who did not use the online program; (2) students who used the online program independently; and (3) students who used the online program with support of an instructor in a hybrid summer math class.

- It is noteworthy that for one teacher (#8) the students who participated in the hybrid summer school class earned lower grades in their 9th grade math classes than the students who participated online. This was not in keeping with my hypothesis that those who participated in the hybrid class would do better than those in the online or no participation groups. However, a t-test was conducted using the Spring NWEA test scores which found that indeed the two groups were not equivalent as the hybrid students had lower Spring NWEA math scores to begin with.
- According to student surveys access to a computer was not a barrier to participation given only 3 students of 116 (2.6%) came into VTHS to access school computers. However, these findings should be viewed with caution as there was no investigation into the reasons for the non-participation by the 194 students who neither attended the hybrid summer math class nor worked independently online during the summer.

Significance of Study in the Field

Many states throughout the country are currently participating in the Race to the Top Federal Initiative and The Partnership for 21st Century Skills which both call for a shift in how students are educated and prepared for gainful employment in today's ever-evolving and changing technological society. Thus, it was relevant to investigate the success of one online learning mathematics program introduced at a vocational technical high school to determine its effectiveness in improving student proficiency in math. Given that online learning programs continue to gain popularity within public school districts it was prudent to investigate the effectiveness of these programs for different types of students with a variety of learning styles. This study was one effort to investigate the impact of this approach to learning for the vocational technical high school student.

Given the lack of controlled research in K-12 public education arena and given the proliferation of both online and hybrid learning opportunities currently available, this study is relevant in that it addressed an under-investigated area of educational research – the vocational technical high school student and their participation in a new online learning environment in mathematics.

While this study investigated only a small subset of high school students - those invited to attend one regional vocational technical high school in Massachusetts with its schedule of alternating vocational and academic classes – it is a contribution to the research that continues to investigate the increasingly popular online learning phenomenon. More study is necessary to determine best practices within the context of online learning and which student populations are best served with this approach to student instruction and learning.

Final Thoughts

While this study contributed to the understanding of how one vocational technical high school selected and implemented a new online learning environment with the hopes of improving student math proficiency in the summer between 8th and 9th grade, more research needs to be done to further deepen the understanding of the factors that contribute to the student success in mathematics both in the hybrid class setting or when utilizing an online math program independently. Further research could also provide a better understanding of why one group of students elected to not participate at all, despite participation being expected for all incoming 9th graders and the freedom to select an elective course upon arrival to the school in the fall. Finally, further research would provide a better understanding of whether students who applied to attend a vocational technical high school with its alternating schedule vocational and academic classes do benefit more from online learning programs than those students who attend a traditional public

high school.

This study considered perspectives of the various stakeholders – administration, faculty, and student experiences - with a newly introduced online learning environment, however, it was unable to identify if online learning, a hybrid model of mathematics instruction, or no participation at all was most effective in improving a vocational technical high school student's math proficiency. Thus more research is indicated to provide a deeper understanding of how to improve math skills of incoming freshman at a vocational technical high school.

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Appendix A

Focus Group Participation Letter from Principal

Dear Student and Parent/Guardian,

DATE, 2011

Ms. Paadre, a teacher at Southeastern will be conducting the research portion of her doctoral program from Northeastern University in June. As part of her research she will be conducting focus groups with freshman students to discuss participation in last summers' online learning (Island) and/or the hybrid classroom program. Her research findings will help us plan for future summer school programming as well as additional online learning opportunities.

I hope you will agree to let her speak with your son or daughter for this very worthwhile project. She is looking for 9th grade students to participate in an afterschool focus group to discuss their experiences and beliefs about their math learning experiences during the summer of 2010. Focus groups will be completed prior the departure of the school buses, so no alternate transportation will be required. The focus groups will be scheduled for June 2011 and if your child is selected, s/he will be provided a specific time and date upon return of the signed informed consent form attached.

All information gathered will be confidential and personal information, including names, will not be used in the final research report. If you have any specific questions or concerns, please contact Ms. Paadre directly at tpaadre@VTHS.org.

Thank you in advance for helping with this exciting project. Please return the attached form if you should agree to your child's participation.

David Wheeler

Principal



Appendix B

Signed Informed Consent Document

Northeastern University, College of Professional Studies
Principal Investigator: Taimi Paadre

Title of Project: Did Learning Mathematics Online increase Students' Math Proficiency?: An Outcome Study of a Vocational High School's use of an Online Mathematics Program

Informed Consent to Participate in a Research Study

Why am I being asked to take part in this Research Study? You have been asked to participate in this study since you are a member of the current (2010/11) freshman class at VTHS. Alternately you are either an administrator or teacher connected with the 2010 summer mathematics online or hybrid learning program at VTHS.

Why is this research study being done? The purpose of this research is to determine which method of summer math instruction is most effective – online or hybrid instruction – for an incoming 9th grade student at the Southeastern Regional Vocational Technical High School (VTHS).

What will I be asked to do?

Students: Participate in a focus group for approximately one hour and share experiences and perspectives of the summer 2010 math learning program.

Administrators and teachers: Share assumptions, expectations and perceptions of the 2010 summer math program.

Where will this take place and how much time will it take? All research activities will take place at VTHS at a time and place convenient to students, teachers and administrators. No academic time will be lost as a result of participation in the research activities.

Will there be any risk or discomfort to me? There is no risk involved in being a participant in this study.

Will I benefit by being in this research? Benefits for administration/teachers is the knowledge of which approach to 9th grade summer math instruction is most effective – online learning or hybrid in school instruction. Benefit for students might include increased insight into personal learning style which may help guide future course selections.

Who will see the information about me? All data collected will be kept in secure locations. Numeric identification numbers rather than student names will be utilized in the

research process. The final research findings and reports will be written up with no identifying information. All data files collected and analyzed regarding student achievement will be destroyed by this investigator upon completion of the research project.

If I do not want to take part in the study, what choices do I have? You are not required to participate in this study. If you do not want to participate, do not sign and instead ignore this form.

What will happen if I suffer any harm from this research? There are no significant risks involved in being a participant in this study.

Can I stop my participation in this study? Participation in this study is voluntary, your participation or non-participation will not affect other relationships (e.g., employer, school, etc.). You may discontinue your participation in this research program at any time without penalty or costs of any nature, character and kind.

Who can I contact if I have questions or problems?

Taimi Paadre - 250 Foundry St. S. Easton, MA 508-230-1200 email: tpaadre@VTHS.org

Chris Unger - College Professional Studies 50 Nightingale Hall Northeastern University, Boston, MA 617-373-2400 email: c.unger@neu.edu

Who can I contact about my rights as a participant? If you have any questions about your rights as a participant, you may contact Nan C. Regina, Director, Human Subject research Protection, 960 Renaissance Park, Northeastern University, Boston, MA 02115 tel. 617-373-

7570, email: irb@neu.edu. You may call anonymously if you wish.

Will I be paid for my participation? There is no compensation for participation in this study.

Will it cost me anything to participate? There is no cost to participate in this study.

I have read, understood and had the opportunity to ask questions regarding this consent form. I fully understand the nature and character of my involvement in this research program as a participant and the potential risks. Should I be selected, I agree to participate in this study on a voluntary basis.

Research Participant - Student (Printed Name): _____

Research Participant - Student (Signature): _____

Participant/Parent/Guardian Signature (Signature): _____

Date: _____



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**Appendix C Student
Survey's Fall 2010
Hybrid Summer School Survey**

Please take a minute to let us know how your summer school experience at VTHS was. This information will help us understand what type of learning is most effective for incoming freshmen.

Thanks for your help!

1. Please enter your 5-digit ID number here:

2. Attending summer school at Southeastern helped improve my math skills.

Strongly Disagree Disagree Agree Strongly Agree

3. Learning math in a classroom with a teacher available to help me is easier for me than learning in other ways (for example-homework, working by myself, etc.)

Strongly Disagree Disagree Agree Strongly Agree

4. I think summer school at Southeastern prepared me for 9th grade math.

Strongly Disagree Disagree Agree Strongly Agree

5. I would attend summer school at Southeastern again if possible.

Strongly Disagree Disagree Agree Strongly Agree

6. Before summer school

_____ Before summer school I felt I was really good at math.

_____ I felt I was ok at math.

_____ I was not really good at math.

7. Did summer school help you become more confident in your math abilities?

YES NO

8. My teacher was very good at helping me in math.

Strongly Disagree Disagree Agree Strongly Agree



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Appendix D
Online Learning Student Survey

1. Please enter your 5-digit ID number here:

2. Online learning this summer helped improve my math skills.

Strongly Disagree Disagree Agree Strongly Agree

3. Learning online was easier than learning in the classroom during the school year.

Strongly Disagree Disagree Agree Strongly Agree

4. I think the online class prepared me for 9th grade math.

Strongly Disagree Disagree Agree Strongly Agree

5. Most of the time for online learning I used the computer at:

- Home
- Library
- Friend's house
- Southeaster Regional

6. The teacher assigned to me by my online mentor helped me learn this summer?

Strongly Disagree Disagree Agree Strongly Agree

7. I would take another online class if I could.

Strongly Disagree Disagree Agree Strongly Agree

8. Before my online class

- I felt I was really good at math.
- I felt I was ok at math.
- I was not really good at math.

9. Did online learning help you become more confident in your math abilities?

YES NO



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Appendix E

Student Focus Group Questions

Focus groups by their nature allow for indepth discussion of a specific topic, thus the questions outlined below are a beginning point to generate conversations to gather a deeper understanding of student experiences.

In School Hybrid Students:

1. Looking back on the year do you think that attending summer school at VTHS helped you with your math class during the year? Why or why not?
2. Did you think the online learning part of the summer class was helpful? Why or why not?
3. Did you think the direct instruction from the teacher was helpful? Why or why not?
4. Had you ever used an online learning program before coming to summer school?
5. How challenging was it to learn to use the program at school?
6. Would you take another in school hybrid class if you had the chance?
7. Would you take an online course if you had the chance?
8. Is there anything else that can help me better understand how the summer experience helped you this year?

Online Students:

1. Looking back on the year do you think that working online this past summer helped you with your math class during the year? Why or why not?

2. Did you miss having direct instruction from a teacher? Why or why not?
3. Had you ever used an online learning program before coming to VTHS?
4. Was accessing a computer a problem? Where did you complete your work?
5. How challenging was it to learn to use the program?
6. Would you take an online course if you had the chance?
7. Is there anything else that can help me better understand how the summer experience helped?



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Appendix F

Hybrid Class Instructor Interview Questions

1. Please describe the program of math you taught at VTHS during the summer of 2010.
2. What is your experience with facilitating a hybrid class? Did you feel you were prepared to teach in this manner?
3. What is your experience teaching math? Where? When?
4. How many students were in the class?
5. How many computers in the classroom?
6. What was the session structured like (how long was the class, the instruction period vs independent online work?)
7. Were most of the students independent in accessing the program or was there need for computer training?
8. How did the students respond to this new approach to math instruction?
9. Did you find it overall to be an effective approach to teaching math?
10. Did you have to clarify a lot of the information the students were working with online? Or was the Study Island program capable of clarifying confusion for students?
11. Did the students seem to enjoy this approach?
12. Did you have challenges with keeping students focused (ie on Study island rather than their email or Facebook?)
13. What were the challenges of this approach to math instruction?

14. What were the positive aspects of this approach to math instruction?
15. Were all students able to access the program (ie SPED, ELL, etc)?
16. Did you enjoy teaching in this fashion?
17. What would you recommend to improve the experience for students?
18. What would you recommend to improve the experience for teachers?
19. If you could change things what would you do differently?

Appendix G
Administration Interview Questions

1. Please tell me about the summer school math program for incoming freshman.
2. Please tell me how the students that are selected to attend summer school for math instruction.
3. How was the summer school math curriculum developed?
4. What was changed this year from previous summer school years with regard to math instruction?
5. How did you decide to incorporate an online course into the curriculum?
6. Were there any unexpected challenges (i.e. computer access, technology limitations, student/teacher skill with technology, etc.)
7. How successful do you think this summer's math program was in comparison to past years?
8. What do you think were the challenges of this year's freshman summer school program?
9. What other programs did you consider before selecting Study Island?
10. How did you make the decision to purchase Study Island versus another program?
11. How did you think the overall math summer program went?
12. Did you observe the students in math class during the summer?
13. Did the students give any feedback about the new online approach to teaching math?
14. Were all students (SPED, ELL, etc) able to access the curriculum as you expected?
15. If not, what were some of the barriers to access?

16. What do you as an administrator see as the benefit of the new approach compared to the previous summer school approach to math?

17. Will you offer the online math component to all incoming freshmen again?

18. What would you do differently in the future?

19. Why would you do it differently?

20. In the end did it meet your expectations?

21. What would you recommend to other schools attempting to implement this approach to student learning?