

**A CASE STUDY OF ONE-TO-ONE COMPUTING:
THE EFFECTS ON TEACHING AND LEARNING**

by

Richard C. Meyer

A Dissertation

Presented to the Faculty of

The Graduate College at the University of Nebraska

In Partial Fulfillment of Requirements

For the Degree of Doctor of Educational Administration

Major: Educational Administration

Under the Supervision of Professor Larry L. Dlugosh

Lincoln, Nebraska

December 2007

**A CASE STUDY OF ONE-TO-ONE COMPUTING:
THE EFFECTS ON TEACHING AND LEARNING**

Richard C. Meyer, Ed.D.

University of Nebraska, 2007

Adviser: Larry Dlugosh

Computer technology is an innovation that has spread rapidly through society and schools. This rapid deployment of technology in schools has created change at all levels of education. Computer technology that was rarely available in schools only a few years ago is now commonplace. However, there is a phenomena occurring in today's schools that may completely change education and the delivery of instruction to students. That phenomenon is the implementation of one-to-one computing environments at the high school level.

The purpose of this study was to evaluate one-to-one computing environments by examining the changes in teaching and student' learning as perceived by teachers and administrators in three Midwestern school districts. The schools are of varying location, enrollment, socio-economic status, and diversity of student population. All three districts have adopted a one-to-one computing environment for high schools in the district and have implemented one-to-one for four or more years. Data were gathered by interviewing teachers and administrators in the three high schools. This data was compared to the claims of computer hardware vendors in regard to changes in teaching and learning in one-to-one computing environments.

Increased student motivation was the top change in student' learning that was identified by the respondents in the study. Increased student active participation, improved student research skills, improved student achievement, increased student responsibility, and increased student interaction and communication with parents, teachers, and other students were the next most frequently mentioned effects. Flexibility in the delivery of instruction was the most frequently mentioned effect in teaching. The next most frequently referenced teaching themes include the following: increased use of digitized learning content and/or on-line learning resources, more active learning strategies, increased use of multimedia resources, and improved communication with students and/or parents. Claims made by computer hardware vendors as to the effects on teaching and learning, with the exception of increased collaboration with the teaching community, were confirmed by at least one respondent in the study.

DEDICATION

To my loving wife, Sheila, and our four children, Quentin, Aaron, Lane, and Cole,
for their boundless love, continuous support, and steadfast encouragement
throughout my career and educational journey.
Without their love, support, encouragement, and sacrifices,
this project would not have come to fruition

TABLE OF CONTENTS

Chapter One – Introduction	1
Definitions.....	10
Purpose of the Study	10
Research Questions.....	11
Significance of the Study	11
Summary of Research Design.....	12
Chapter Two – Literature Review.....	14
Student Engagement Theory.....	14
Computers in Learning	17
Promotional Materials Distributed by Computer Vendors	39
Summary	47
Chapter Three – Methods.....	48
Research Design.....	48
Researcher’s Role	48
Context for the Study	49
Data Collection Procedures.....	51
Research Questions.....	53
External Validity.....	53
Internal Validity	53
Data Analysis	54
Limitations of the Study.....	55
Summary of the Methods.....	55

Chapter Four – Findings of the Research	57
Participants.....	57
Interview Themes.....	58
Findings.....	60
Building Responses.....	68
Chapter Five – Conclusions and Recommendations	72
Introduction.....	72
How Has Student’ Learning Changed?.....	72
How Has Teaching Changed?.....	76
How Has the Role of School Administrators Changed?.....	79
How Has Student’ Engagement in the Learning Changed?.....	82
Summary	83
Recommendations for Further Study	84
References.....	87
Appendices.....	98
Appendix A: Teacher and Administrator Recruiting Script	98
Appendix B: Administrator Interview Questions	100
Appendix C: Teacher Interview Questions.....	102
Appendix D: Informed Consent Form	104
Appendix E: Institutional Review Board Approval Letter	107

LIST OF TABLES

Table 1	Percent of U.S. Public Schools Having Access to the Internet.....	2
Table 2	Percent of Instructional Computers in U.S. Public Schools With Access to the Internet.....	2
Table 3	Number of U.S. Public School Students Per Instructional Computer With Access to the Internet.....	3
Table 4	U.S. Public School Students With Access to a Home Computer Used to Complete Homework.....	4
Table 5	U.S. Students Using a Computer at School in 2003	4
Table 6	U.S. Students Using a Computer at School in 2003	5
Table 7	U.S. Students Using a Computer at School in 2003	5
Table 8	U.S. Students Using a Computer at Home in 2003	6
Table 9	U.S. Students Using a Computer at Home in 2003	6
Table 10	U.S. Students Using a Computer at Home in 2003	7
Table 11	Demographics of Schools Included in the Study.....	50
Table 12	Enrollment by Race/Ethnicity.....	50
Table 13	American College Test (ACT) Performance	50
Table 14	Interviews Conducted.....	52
Table 15	Interview Participants	57
Table 16	Identified Themes for the Effects of One-to-One Computing on Student Learning.....	59
Table 17	Identified Themes for the Effects of One-to-One Computing on Teaching	60

Table 18	Reponses to Student Learning Themes.....	61
Table 19	Responses to Teaching Themes.....	62
Table 20	Top Five Teacher Reponses to Student Learning Themes	64
Table 21	Top Five Administrator Reponses to Student Learning Themes.....	64
Table 22	Top Five Teacher Responses to Teaching Themes	67
Table 23	Top Five Administrator Responses to Teaching Themes.....	67
Table 24	Top Five Reponses to Student Learning Themes at Lake HS	68
Table 25	Top Five Responses to Teaching Themes at Lake HS	68
Table 26	Top Five Reponses to Student Learning Themes at Plains HS	69
Table 27	Top Five Responses to Teaching Themes at Plains HS.....	69
Table 28	Top Five Reponses to Student Learning Themes at Riverside HS.....	69
Table 29	Top Five Responses to Teaching Themes at Riverside HS	70

Chapter One

Introduction

Computer technology is an innovation that has spread rapidly through society and schools. This rapid deployment of technology in schools has created change at all levels of education. Computer technology that was rarely available in schools only a few years ago is now commonplace. However, there is a phenomena occurring in today's schools that may completely change education and the delivery of instruction to students. That phenomenon is the implementation of one-to-one computing environments at the high school level.

In 1981 only 18.2% of the schools had a computer (U.S. Bureau of the Census, 1985). By 1984, 85.1% percent of public schools had computers; in 1992, 98.5 % of schools had computers (U.S. Bureau of the Census, 1994). In 1984, there were, on average, 63.5 students per computer; by 1992, there were 12 students per computer (U.S. Bureau of the Census, 1994). By 2003, the latest data provided by the U.S. Bureau of the Census in 2006, schools were able to lower the student to computer ratio to 4.0 (U.S. Bureau of the Census, n.d.). Student use of computers at school has also increased. In 1993, 61.6% of all public elementary and secondary students used computers at school (National Center for Education Statistics, U.S. Department of Commerce, & Census Bureau, 2005). Student use of computers at public schools increased to 72.1% in 1997 and 85.4% in 2003 (National Center for Education Statistics et al., 2005). Student access to resources on the internet has also increased dramatically. Internet access for schools increased from 35% in 1994 to 100% by 2003 (U.S. Bureau of the Census, 2006; Parsad & Jones, 2005).

Table 1

Percent of U.S. Public Schools Having Access to the Internet

Year	
1994	35
1995	50
1996	65
1997	78
1998	89
1999	95
2000	98
2001	99
2002	99
2003	100

In 1994, only 3% of instructional classrooms had internet access, while in 2003 93% had access (U.S. Bureau of the Census, 2006; Parsad & Jones, 2005).

Table 2

Percent of Instructional Computers in U.S. Public Schools With Access to the Internet

Year	% of Schools
1994	3
1995	8
1998	50
1999	62
2000	77

2001	85
2002	90
2003	93

At the same time, the ratio of students to instructional computers with access to the internet has rapidly declined. In 1998, there were 12.1 students per instructional computer with internet access, while that ratio had dropped to 4.4 in 2003 (Parsad & Jones, 2005).

Table 3

Number of U.S. Public School Students Per Instructional Computer With Access to the Internet

Year	Students
1998	12.1
1999	9.1
2000	6.6
2001	5.4
2002	4.8
2003	4.4

Computer technology and use has also become commonplace for many public school students in their home. In 1993, only 23% of public school students used a computer in their home, and only 11.7% of public school students used a home computer for school work (National Center for Education Statistics et al., 2005). By 2003, 66.3% of students had a home computer, and 47.8% of students used their home computer to complete school work (National Center for Education Statistics et al., 2005).

Table 4

U.S. Public School Students With Access to a Home Computer Used to Complete Homework

Year	% With Home Computer	% Using to Complete Homework
1993	23.0	11.7
1999	43.2	27.9
2000	66.3	47.8

Student access to computers in schools appears to be fairly equitably distributed across gender, racial, and socio-economic factors (National Center for Education Statistics et al., 2005). There are some differences in race where Hispanic students have lower use of computers in school. Students from low-income families also have lower use of computers in school. While there are some differences in student use of computers at school based on race and socio-economic levels, these differences are not significantly large. However, the data does not reflect the quality or quantity of students' use of school computers. There may be significant differences in the quality of computer hardware and software from school to school and in the quantity of time students are able to use school computers. Tables 5, 6, and 7 show the levels of access to computers at school based on gender, race, and income levels (National Center for Education Statistics et al., 2005).

Table 5

U.S. Students Using a Computer at School in 2003

Gender	% of Students
Male	83.4
Female	83.5

Table 6

U.S. Students Using a Computer at School in 2003

Race	% of Students
White	84.9
Black	82.5
Hispanic	79.8
Other	81.7

Table 7

U.S. Students Using a Computer at School in 2003

Family Income	% of Students
Less than \$5,000	79.5
\$5,000 to \$9,999	82.4
\$10,000 to \$14,999	80.0
\$15,000 to \$19,999	79.8
\$20,000 to \$24,999	80.3
\$25,000 to \$29,999	81.3
\$30,000 to \$34,999	82.5
\$35,000 to \$39,999	87.5
\$40,000 to \$49,999	84.2
\$50,000 to \$74,999	84.0
\$75,000 and more	85.6

Student use of computers at home is not as equitably distributed as student use of computers at school. In schools there are small differences in use by groups across gender, race, and socio-economic factors. However, in terms of home use of computers by students, there are vast differences across the various groups (National Center for Education Statistics et al., 2005). White students and families with higher socio-economic levels have much higher home computer use levels than the other groups. Tables 8, 9, and 10 show the levels of access to computers at school based on gender, race, and income levels (National Center for Education Statistics et al., 2005).

Table 8

U.S. Students Using a Computer at Home in 2003

Gender	% of Students
Male	66.8
Female	68.3

Table 9

U.S. Students Using a Computer at Home in 2003

Race	% of Students
White	78.3
Black	46.2
Hispanic	47.5
Other	71.3

Table 10

U.S. Students Using a Computer at Home in 2003

Family Income	% of Students
Less than \$5,000	29.8
\$5,000 to \$9,999	36.6
\$10,000 to \$14,999	39.3
\$15,000 to \$19,999	40.8
\$20,000 to \$24,999	46.6
\$25,000 to \$29,999	54.7
\$30,000 to \$34,999	61.5
\$35,000 to \$39,999	67.8
\$40,000 to \$49,999	73.4
\$50,000 to \$74,999	79.5
\$75,000 and more	87.6

According The CEO Forum School Technology and Readiness Report (2001), “In the global digital economy, technology is rapidly changing how people live and work. Now we need to harness technology to benefit our nation’s schools, communities and, most importantly, students.” A report prepared by the United States Department of Education in 2004, *Toward a New Golden Age in American Education*, calls for increased support of e-learning, innovative budgeting to support technology in schools, increased access to the internet for students, and a move towards more digital content. The report encourages broadband access 24 hours a day, seven days a week, 365 days a year to help students and teachers realize the full potential of the technology. The report concludes “There is no dispute over the need for America’s students to

have the knowledge and competence to compete in an increasingly technology-driven world economy.”

Parents and students also believe that more technology needs to be integrated into schools. The results of the fourth annual Speak Up survey of K-12 students, parents, and teachers released in March of 2007 showed that over two-thirds of parents are unsatisfied with the amount of time their children are spending using technology in school and how well the technology is being integrated into core academic subjects (Appel, 2007). According to the survey, one-fourth of students use e-mail to contact their teachers and one-third are interested in taking an online class.

Schools have used and are using a significant portion of their budgets and limited resources to provide access to computers and the internet for students and teachers. In 2005, it was anticipated that K-12 schools would spend more than \$7 billion in new technologies (Murray, 2004).

A number of school districts and several states have developed and implemented plans to create a one-to-one ratio of computers to students in their schools. The students would also have 24 hour a day, 7 days a week access to their computers and the internet. Henrico County Virginia schools implemented one of the largest school district one-to-one programs in the fall of 2001 with the purchase of 23,000 Apple i-books (eSchool News staff and wire service reports, 2001). According to eSchool News, (one-to-one computing) “permits ‘total computer access’ for students in the diverse school district, is designed to open up a world of information to children of every socioeconomic background.”

The State of Maine has been one of the leaders in adopting one-to-one programs for students. In 2002 Maine distributed approximately 17,000 laptop computers for all 7th grade

students and their teachers. An additional 17,000 laptop computers were distributed in the fall of 2003 for all new 7th grade students. The primary goal of Maine's program is help students acquire 21st Century skills using technology (Gritter, 2005). Michigan and Indiana have implemented or developed pilot projects that provide one-to-one computing opportunities for students (Brumfield, 2005).

Computer vendors such as Apple, Dell, Gateway, Hewlett-Packard, IBM (Lenovo), Toshiba, and others are promoting the adoption of one-to-one computing environments in K-12 schools. These vendors have produced a variety of brochures, web pages, booklets, white papers, and research papers that promote the adoption of one-to-one computing. They obviously have an interest in developing new markets for their products and see K-12 schools as a potentially large consumer of product, especially if one-to-one computing environments are universally adopted.

As schools, administrators, boards of education, and communities across the county consider establishing one-to-one computing environments, there is a need for evaluative information to assist in the decision-making process. Implementing a one-to-one computing environment requires a great deal of resources in a time when budget resources are scarce. School district administrators and board of education members who wish to base budget decisions on evidence of student learning outcomes may feel that the existing evaluations are biased since most of them are produced by the vendors who are selling the products. Some school districts are ending their one-to-one programs because of the ongoing repairs and expense, disruption to the learning process, and a lack of evidence related to improving student learning (Hu, 2007). Evaluations which examine the relationship between one-to-one computing

specific to student learning should provide valuable information to aid in the decision-making process.

Definitions

The following definition will be used throughout the course of this study:

- **One-to-One Computing Environment:** A school where all students and faculty members have been given a laptop computer to use for the school year, twenty-four hours a day, seven days per week, and where a wireless network has been installed in the school so that all laptop computers may connect to the network at any time.

Purpose of the Study

The purpose of this study was to evaluate one-to-one computing environments by examining the changes in teaching and student learning as perceived by teachers and administrators in three Midwestern school districts. The districts are of varying enrollment sizes, socio-economic status, and diversity of student population. All three districts have adopted a one-to-one computing environment for high schools in the district and have implemented one-to-one for four or more years.

The information generated by this study is intended to contribute to the knowledge base regarding one-to-one computing, and to aid decision makers as they consider adopting one-to-one computing environments for their schools. The results of the study will be shared with the districts participating in the study, as well as with other individuals or schools that may benefit from this information.

Research Questions

The grand tour research question posed by this study was: How has teaching and learning changed in a high school that has adopted a one-to-one computing environment? Sub questions that were also addressed include the following:

- How has the one-to-one computing environment changed how students learn?
- How has the one-to-one computing environment changed the way teachers teach?
- How has the role of school administrators changed in a one-to-one learning environment?
- How has student' engagement in the learning changed in a one-to-one environment?

Significance of the Study

The intent of this study was to provide information useful to the improvement of learning and teaching through the adoption of one-to-one computing environments. The study was significant for several reasons. The question as to the impact of one-to-one computing on student learning, which is being widely adopted across the country, has yet to be answered. Many school districts are investing large sums of money on one-to-one computing environments in the belief that student learning will be improved and enhanced. Computer hardware vendors are making marketing claims regarding the positive impact of one-to-one environments on student learning. How has all of this affected how teachers teach? Have teachers changed the methodologies used in the classroom when they are in a one-to-one environment?

The study was designed to make a contribution because decision-makers and practitioners have need of information to guide choices about budget, curriculum, and instruction. This study specifically addressed decision makers' needs for information about the impact of one-to-one computing on student learning and classroom instruction. For example, if one-to-one computing is found to enhance student learning and increase student engagement in

the learning, it could be viewed as worth the extra dollars for implementation. However, if one-to-one computing is found to increase student attendance and reduce discipline referrals, but have no significant impact on student learning or the methods used by teachers in the classroom, schools would need to determine if the funding to implement one-to-one computing was a priority over other budget needs in the school. Currently these questions can not be answered with certainty. This study was designed to provide the needed information for effective and efficient educational programming as related to one-to-one computing. It should prove useful in a practical sense for school administrators and board members as they make decisions about program implementation and in a theoretical sense as it adds to the knowledge base related to the adoption of one-to-one computing environments.

Summary of Research Design

Three Midwestern high schools that adopted one-to-one computing environments were invited to participate in the research project. All school administrators in each high school were invited to participate in an interview regarding their perceptions of the impact of a one-to-one computing environment on teaching and learning. Administrators were also asked how their jobs have changed since the implementation of one-to-one computing. In addition, administrators were asked to identify teachers who have embraced one-to-one computing and have changed their teaching methodologies since one-to-one computing was introduced in the building. In one school, Riverside High School, the administration did not allow the researcher to ask administrators to identify teachers for participation in the study. At Riverside, the principal sent an e-mail to all teachers and asked for volunteer teachers to participate in the study.

A list of teachers recommended by their administrator for inclusion in the study, or volunteer teachers in the case of Riverside High School, was compiled. All teachers on the list

were invited to participate in the study. Four to eight teachers from each building, all teachers on the compiled list, agreed to participate and were interviewed for the study. Teachers were asked about the changes they have seen in student learning and how their teaching methodologies have changed since the implementation of the one-to-one computing environment. The interviews were analyzed to determine themes and patterns related to teaching and learning.

Chapter Two

Literature Review

The literature review will be an integrative review based upon the following outline. First, a discussion of engagement theory as it relates to student achievement will be presented. Second, literature as it relates to the effects of using computer technology on learning and the phenomena of one-to-one computing will be reviewed. And lastly, a review of literature that reviews the promotional materials produced by computer hardware vendors in their efforts to market one-to-one computing environments to K-12 schools. In conclusion, a summary of the review that captures the major themes will be presented.

Student Engagement Theory

Educators have used a variety of indicators to measure the achievement of students and schools. Researchers in some schools are measuring student engagement in learning by attendance and behavior referrals in an effort to show growth in student learning enhanced by the implementation of one-to-one computing environments (Metiri Group, 2006). Newmann (F. M. Newmann, 1992) lists the following as some of the indicators that have been used to measure student learning: attendance, credits earned, grades, and performance on a variety of tests and assessments (standardized achievement tests, college admission tests, mastery tests constructed by schools, district, state, and national tests, and teacher made tests). Newmann makes the case that each of these indicators of achievement is deficient in some way in measuring the goals of schooling. Newmann defines student engagement in academic work as “the student’s psychological investment in and effort directed toward learning, understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote” (F. M. Newmann, Wehlage, & Lamborn, 1992). The use of “psychological investment” implies much more than

simply being in school, completing one's assignments on time, or getting good grades.

“Psychological investment” and “effort to master knowledge” are not readily observable or measurable characteristics. That may be why Newmann, Wehlage, and Lamborn reported that there is a lack of correlation between engagement and achievement. The lack of correlation may also be due to the fact that many low-achieving students are highly engaged in school because it is difficult for them, and, conversely many high-achieving students are successful in school with low levels of engagement because they find school to be relatively easy. Measuring student engagement in learning by using attendance, behavior, grades, and test scores may be an indicator of a students' engagement in learning, but it may also be a much too simplistic view of academic engagement.

“Engagement in schoolwork involves both behaviors and emotions” according to the Committee on Increasing High School Students' Engagement and Motivation to Learn (Committee on Increasing High School Students' Engagement and Motivation to Learn, Board on Children, Youth, and Families Division of Behavioral and Social Sciences and Education, 2004). The Committee suggests that engagement is more than motivation, as students may be motivated to attend and participate in the social activities of the school without making academic progress. According to the Committee, activities that engage students' interest and enthusiasm for schoolwork have the following qualities:

- emphasis on high-order thinking
- active participation
- variety
- collaborative activities
- meaningful connections to students' culture and lives outside of school

The Committee does not suggest any methods for measuring student engagement or disengagement from school, but does suggest that academic achievement (grades and test scores), attendance, and behavior are indicators of student engagement.

The 2006 High School Survey of Student Engagement (Voices of Students on Engagement, 2007) surveyed 81,499 students in 110 schools from 26 different states to understand what students think about the life and work of their high schools. In analyzing the survey data, three primary dimensions of engagement were developed: Cognitive/Intellectual/Academic Engagement, Social/Behavioral/Participatory Engagement, and Emotional Engagement. The survey found that 43% of respondents spend 1 hour or less on written homework each week and 55% of respondents spend 1 hour or less each week on reading/studying for class. 50% of the students reported that they are bored in high school every day, and 17% say they are bored in every class. Students were also asked to identify the kinds of class work that would excite or engage them in the learning. Overall, students were most engaged by teaching methods in which they learn with their peers or where the students were active participants in the learning. The most engaging methods identified by the respondents were: discussion and debate, group projects, presentations, role plays, and art and drama activities. Teacher lecture was the least engaging activity identified by the students.

Kuh (What Student Engagement Data Tell, 2007) makes the point that college students who are engaged in their learning generally get better grades, are more satisfied with their college experience, and are more likely to persist in getting a degree. According to Kuh, more than 90 percent of high school seniors say they intend to pursue postsecondary education, but many do not engage in the educational activities that will prepare them for college. Kuh

encourages postsecondary institutions to create educationally effective programs to increase student engagement in learning to increase achievement and satisfaction with learning.

Engagement is not only an issue with high school and college students, but also with working adults. The Gallup Organization (Nurses May Be Satisfied, 2002) found only 30% of workers, 18% among nurses, engaged in their work in the U.S. working population. 54% were not engaged in their work, and 16% were actively disengaged. Engaged workers are loyal, more productive, have fewer accidents on the job, and are psychologically committed to the organization. Gallup defines actively disengaged workers as “physically present but psychologically absent.”

Computers in Learning

ROCKMAN ET AL (2006) reviewed several project reports and reported the effects on teaching and learning when laptops are introduced into the school environment. In one project, (Indiana's TECH-KNOW-Build Project:, 2006), teachers reported, anecdotally, that students have greater engagement in their assigned work, increased motivation, fewer behavioral referrals, and higher attendance. However, analysis of achievement data and writing assessments showed few differences between one-to-one students and students in a more traditional setting. Indiana's TECH-KNOW-Build Project: (2006) did find that students think that laptops help them learn and that 21st Century Learning Skills increased. ROCKMAN ET AL (2006) suggests that the positive effects may provide enough rationale for school administrators to develop laptop programs even though achievement on standardized tests and writing assessments may not increase.

Shapley, Sheehan, Sturges, Caranikas-Walker, Huntsberger, and Maolney (2006a) studied the effects of technology immersion on teaching and learning by observing sixth-grade

classrooms in Texas that had been immersed with laptops. The immersed classrooms were compared to a control group of classrooms. The ratio of computers in immersed classrooms were significantly increased but were short of accomplishing a one-to-one ratio of laptops to students. The report found that the immersed classrooms, teachers began to organize their classrooms differently by moving away from whole class instruction to more time working individually or in small groups, the intellectual rigor of the classrooms increased, and student engagement increased over the course of the school year.

After studying the first-year results of the Texas Immersion Pilot, Shapley, Sheehan, Sturges, Caranikas-Walker, Huntsberger, and Maolney (2006b) found mixed results on indicators of student engagement in learning. Students in computer immersed schools compared to control groups had higher satisfaction with school and fewer behavioral and disciplinary problems. However, the researchers found no significant difference in attendance rates. The study also concluded that there was no significant effect of laptop immersion on student achievement as measured by the Texas state assessment (TAKS). The researchers theorized that the implementation of laptop computers in immersed classrooms varied widely that may have affected the results of the study and will require more analysis in future years of the project.

In a study of 10 schools in Maine and California that have implemented some form of one-to-one computing, Warschauer (2007) found that the laptop classrooms had an advantage in facilitating 21st Century Learning Skills. He also found that students in laptop classrooms had more opportunities for just-in-time learning, individualized learning, and empirical investigation. Warschauer (2007) also found that the use of laptops made it more feasible for students to engage in research projects and created better possibilities for in-depth learning. However, the research showed that the beneficial outcomes did not occur evenly across the schools in the

study. Warschauer (2007) concluded that laptops will not make bad schools good, but they will make good schools better, and one-to-one computing is an invaluable tool in helping students develop 21st Century Learning Skills.

The Greaves Group, The Hayes Connection (2006) surveyed superintendents, curriculum directors and technology directors in school districts with more than 2,500 students. The survey found that 19% of all student computing devices in schools were mobile in 2006 but predicted that by 2011 50% of student devices will be mobile. Currently 3.8% of students use online learning courses while that is expected to grow to 15.6% by 2011. 88% of technology directors who track student academic performance indicate significant academic improvement from implementing one-to-one computing environments. Superintendents and curriculum directors indicated that staff development is perhaps the single largest factor in determining the success or failure of one-to-one implementation.

Researches at Stanford University are using a grant from the MacArthur Foundation to study how technology shapes the manner in which students learn (Researchers study how,2006). Constance Yowell, the foundation's director of digital media, maintains that "kids are using digital technology in incredible ways". Yowell goes on to say that "this is peer-driven learning". The foundation has found that more than half of American teens use a computer on a daily basis and 40 percent play a video game daily. Stanford researcher Brigid Barron concern is that computing technology may be increasing differences among groups along typical lines such as gender, ethnicity, and socio-economic level. Barron asserts that the issue is not necessarily access to technology, but student's access to doing interesting things with the technology.

The Buddy System Project provided fourth, fifth, and sixth grade students with computer equipment at home while also providing the students' schools with approximately 22 additional

computers (Duffy & McMahon, 1999). Case studies were conducted on participants from four sites that were involved in the project. The studies revealed that that students self esteem improved, students, particularly with special needs, were equalized, a cooperative learning environment involving teachers and students as partners was promoted, students were more willing to do school work and homework, and the amount and detail of student writing increased. Some parents, confirmed by teachers, also observed increased student grades in school during the project. While all students in the study had access to a computer at home, that was not always the case at school, which may have limited the effects of the program.

CEO Forum on Education and Technology (2001) sought to answer how and why educational technology created a positive impact on education. Key finding of their analysis include the following:

- Education technology can improve student achievement.
- Technology can have the greatest impact when integrated into the curriculum to achieve clear, measurable educational objectives.
- Assessment is not currently aligned with educational objectives, or adequately measuring 21st Century Skills.
- Measurement and continuous improvement strategies have not been widely implemented in schools and districts.

When applied to well-defined educational objectives, and integrated into the curriculum by trained teachers, education technology can produce dramatic results for students, including improved scores on standardized tests.

Zhao, Pugh, Sheldon, and Byers (2002) studied teachers' experiences with using technology to support teaching in schools and the conditions under which technology integration

can occur. The conclusions of their study emphasize the importance of staff development to understand how technology might be used to support teaching and learning, the belief that teachers should evolve in their use of technology in the classroom by taking small but progressive steps toward change, and the need for teachers to have easy access to the technology for their students. The authors make the point that for technology to have an impact on teaching and learning, teachers and students must have access to the technology at all times.

The digital divide still exists for students, especially at home (eSchool News staff and wire service reports, 2006). White students have much greater access to the internet at home than do Hispanic and black students. The article uses statistics from a study by the National Center for Education Statistics (DaBell & Chapman, 2006) based on a national survey of households in 2003. Findings from the study include the following:

- The gaps in internet usage between whites and minorities, though sizable, are smaller during the school day.
- Household income, parent education, and whether the home has two parents all correlate with high computer and internet use at home.
- The gender gap in computer usage has all but disappeared.

Larry Cuban has been critical and skeptical of the need for schools to adopt a one-to-one computing environment (Cuban, 2006). Cuban claims that what most districts find from adopting one-to-one environments is increased student motivation, more engagement in lessons, and increased interest in learning. Cuban states that one-to-one computing, as well as all other technology introduced in the past 80 years, has failed to show a direct link to improved test scores. According to Cuban, one-to-one supporters mistake the medium for instruction, laptops, for how teachers teach, and that instruction is responsible for achievement gains, not laptops.

Moore (The 'brutal facts' of 1-to-1, 2006) also questions the implementation of one-to-one computing initiatives in high schools. Moore identifies three “brutal facts”: hardware and software affordability, providing sufficient, high-quality staff development for teachers, and the lack of evidence that one-to-one computing has a positive effect on student achievement. Moore also argues that 21st century learning skills, while important, will not magically appear in one-to-one learning environments. While Moore is skeptical of one-to-one computing implementations of the past, states that “the new vision for one-to-one computing in our schools inevitably will come to pass”.

U.S. Department of Education Secretary Richard W. Riley outlined the National Educational Technology Goals in a report to Congress (U.S. Department of Education, 2000).

The National Educational Technology Goals from 2000 are:

- Goal 1: All students and teachers will have access to information technology in their classrooms, schools, communities and homes.
- Goal 2: All teachers will use technology effectively to help students achieve high academic standards.
- Goal 3: All students will have technology and information literacy skills.
- Goal 4: Research and evaluation will improve the next generation of technology applications for teaching and learning.
- Goal 5: Digital content and networked applications will transform teaching and learning.

The report states, “With sufficient access and support, teachers will be better able to help their students comprehend difficult-to-understand concepts and engage in learning, provide their students with access to information and resources, and better meet their students’ individual

needs. If we take advantage of the opportunities presented to us, technology will enhance learning and improve student achievement for all students.” This statement suggests that through the use of technology students will be more engaged in learning and that student achievement will be improved for all students. In addition the report addresses the need to bridge the “digital divide” and provide equitable access for all students. The report states, “The disadvantages of inequitable access to technology in schools and classrooms are compounded by the fact that students with limited access to technology in school are also less likely to have access to computers and the Internet at home.” Student engagement in learning is one of the outcomes of technology use as the report states, “One of the most promising uses of technology in education involves teachers helping students actively engage in learning.” The report also lists selected examples of research on the effectiveness of educational technology. While a number of the research findings indicated increased achievement, most of the gains appear to be related to increased motivation and acquisition of 21st Century skills that may not be measured by current assessments.

Wireless laptop carts and online courses will be among the hottest high-tech sellers in schools during the 2004-05 school according eSchool News (Murray, 2004). “Mobility and flexibility are the standouts...exploring options for more customizable, individualized instruction, research suggests.” The report also states, “Though most schools still cannot afford to provide a laptop computer for every student, many are exploring innovative, more cost-effective ways to work with the mobile devices, research suggests.”

One of the largest implementations of a one-to-one computing environment was deployed by the Henrico County, Virginia schools (eSchool News staff and wire service reports, a). 23,000 laptops were provided for all middle level and high school students and teachers as part

of an \$18.5 million deal with Apple Computer beginning in 2001. According to the article, students will have access to more information and the internet, as well as equalizing the opportunity for all students in this district with learners from diverse backgrounds. During the 2004-05 school-year, the Board of Education authorized a study of the opinions of students, parents, teachers, and administrators involved in the laptop program (Davis, Garas, Hopstock, Kellum, & Stephenson, 2005). Key findings of this study related to student learning include:

- Among middle level and high students there are no differences in iBook, laptop, use by gender or free/reduced lunch status, however, there are small differences in use race/ethnicity.
- Middle level and high school students primarily use their iBooks for class work, homework, and conducting research on the Internet.
- Middle level and high school students believe that iBook access to the Internet makes research easier and that iBook use helps them to be better organized.
- Middle level and high school students are not all convinced that iBook use helps them to do better in school.

“Budgeting realities” have kept most states and districts from implementing one-to-one computing environments (Brumfield, 2005). Budget cuts have led Michigan to consider ending its one-to-one laptop initiative for all 6th graders in the state. On the other hand, Indiana chose to implement a one-to-one desktop initiative as an alternative to laptops because of the expense. The report states that Indiana officials believe the presence a classroom computer for each student decreases behavior, increases attendance, and increases the engagement of students in the learning.

ROCKMAN ET AL (2000) examined the impact of one-to-one computing with laptops on students and teachers during the third year of Microsoft's Anytime, Anywhere Learning Program. The researchers were specifically asked to examine ways in which laptops might be supporting a more constructivist pedagogy and the impact of one-to-one computing environments on standardized test scores. The research findings regarding the impact on student learning included better performance on writing assessments, no difference in standardized test scores, more time spent on homework, and higher confidence in computer skills.

Zucker and McGhee (2005) studied the 2001 implementation of one-to-one computing environments in the Henrico County Public Schools. The study primarily focused on math and science classrooms. Findings related to student learning included greater access to information for students, increased student motivation, increased student engagement and interest in learning, more student self-directed learning, better organized students, and increased student interaction with teachers.

Walled Lake Community Schools in Michigan were involved in the Anytime, Anywhere Learning (Laptop Program) beginning with the 1999-2000 school-year. The program was evaluated each year for three years to determine the effectiveness of providing 5th, 6th and 7th grade students with access to laptop computers with regard to classroom learning activities, technology usage, and writing achievement (S. M. Ross, Morrison, Lowther, & Plants, 2000), (S. M. Ross, Lowther, & Morrison, 2001), and (S. M. Ross, Lowther, Wilson-Relyea, Wang, & Morrison, 2003). Findings from the studies found a significant increase in writing performance, students were engaged in more cooperative learning in laptop classrooms, increased problem-solving performance for laptop students on 5 out of 7 indicators, and student achievement for laptop students in mathematics was significantly higher than for cart students.

Apple Classrooms of Tomorrow (ACOT) Evaluation Study (Baker, Gearhart, & Herman, 1990) focused on the impact of providing computers for teachers and students at school and at home. Data collected by the study included students' achievement on standardized tests, writing performance, and attitudes. Results showed that ACOT students maintained their performance levels on standard measures of educational achievement in basic skills, and they sustained positive attitudes on measures addressing the traditional activities of schooling. Informal observation by the researchers suggests the experience of ACOT itself appears to be resulting in significant new learning experiences for students and greater attention to complex, higher level processing skills.

Fryer (2004) studied the effects on attendance for a one-to-one computing adoption at Floydada Junior High School in Floydada, Texas. Student attendance prior to the distribution of laptops in October was compared to student attendance after the distribution. The researcher found that attendance had decreased after the implementation of the one-to-one environment. Illness caused by seasonal allergies and absences related to the Thanksgiving holiday may account for the lower attendance rates.

Wenglinsky (1998) used data drawn from the 1996 National Assessment of Educational Progress (NAEP) to determine if computer use is making a difference in mathematics achievement. He found that when computers were used to apply higher order concepts and when teachers were proficient enough in computer use to direct students toward productive uses, computers were associated with significant gains in mathematics achievement. The study also found that students using home computers frequently had higher levels of achievement in eighth grade, but lower levels of achievement in fourth grade. The study suggests that federal and state policymakers should amplify their efforts to ensure that teachers are properly trained to use computers. Federal and state policymakers should make sure that the quality of the teacher training offered is of high quality and intensive, since training is such an important aspect of making technology use successful.

The study also suggests that teachers should focus on using computers to apply higher-order skills learned elsewhere in class. The researcher believes that the primary focus of all technology initiatives should be on middle schools rather than elementary schools, since the effects of technology appear to be much smaller in the fourth than the eighth grade, and so may not be cost-effective.

Laptop computer computers were introduced into the Beaufort County Schools through the Middle School Laptop Project during the 1996-97 school-year (K. R. Stevenson, 1998) and (K. R. Stevenson, 1999). The project was expanded to include a new group of sixth graders during the 1997-98 and 1998-99 school years, so that laptops were in use at all three grades of the middle school during the third year of the project. However, the Beaufort laptop project was voluntary with students and their parents deciding if it was worth the expense. Since the participants of the study were not randomly selected, it is possible that factors other than participation in the program may have been responsible for the results of the study. Findings after two years and three years of implementation were similar. Findings from the project include the following:

- Students using the laptops maintained, but did not increase, their scores on standardized achievement tests over time. Standardized achievement test scores of non-laptop students dropped over time.
- Both students and teachers thought that use of the laptops would have more impact ultimately on high school academic performance than middle school achievement.
- Free and reduced lunch students using laptops scored higher on standardized achievement tests than free and reduced lunch students not using laptops. After the second year of the project, free and reduced students using laptops scored approximately the same on standardized achievement tests as non-free and reduced students.

- Female students participating in the laptop project scored as well as male participants on standardized achievement tests.

Liverpool High School in Liverpool, New York, introduced its laptop program beginning with the 2000-01 school-year (K. R. Stevenson, 2004). Student participation in the laptop program was voluntary. The Year 3 study examined data relating to student attendance, behavior, and grades. The researcher was seeking to find any differences in actual student performance that might be related to participation in the laptop program. Consequently, the study focused on twelfth grade students who had now used laptops for three years. The researcher found the following results:

- Laptop students missed fewer days of school than non-laptop students. However, laptop student missed fewer days of school than non-laptop students prior to the introduction of laptops.
- Laptop students had fewer disciplinary referrals than non-laptop students. However, laptop students had fewer disciplinary referrals than non-laptop students prior to the introduction of laptops.
- Laptop students had a higher end of the year grade point average than non-laptop students. However, laptop students had a higher end of the year grade point average than non-laptop students prior to the introduction of laptops.
- In all three measures used by the researcher, attendance, behavior referrals, and end of the year grade point average, the differences between the laptop users and non-laptop users grew over the three years of the study.

While it is difficult to draw many conclusions about the effects of laptops on student learning from this study, the study does confirm that laptop use by students does not appear to have a negative effect on learning.

A one-to-one computing environment for 4th and 5th grade students was compared to classroom environments where students were provided computer access by cart of thirty laptops shared between all 4th and 5th grade classrooms at South Elementary School in Andover, Massachusetts (Russell, Bebell, & Higgins, 2004). Five classrooms shared a cart of laptops while four classrooms had a one-to-one environment. The results may be skewed because the one-to-one participants were responsible for paying for the laptop computer or applying for a scholarship to pay for the computer. Since the students were not selected randomly, other factors may have impacted the results of this study. The major findings from this study include the following:

- One-to-one students used computers more at home more for academic purposes than students in computer cart classrooms.
- Students in one-to-one environments were more motivated and engaged than students in computer cart classrooms.
- One-to-one students spend more time writing than students in computer cart classrooms.

The effect of computers on student writing was studied by meta-analyses that included 26 studies conducted from 1992 to 2002 that focused on the comparison of K-12 students writing with computers vs. writing with paper-and-pencil (Goldberg, Russell, & Cook, 2003).

Significant mean effect sizes favoring writing with computers were found for quantity of writing ($d=.50$, $n=14$) and quality of writing ($d=.41$, $n=15$). On average, the effect of writing with computers on both the quality and quantity of writing was found to be larger for middle and high school students than for elementary students. Mixed results were found for studies focused on revision behaviors between the two writing conditions ($n=6$). Other studies ($n=35$) collected for the meta-analysis which did not meet the statistical criteria were also reviewed briefly. A review of these articles indicates that the writing process is more collaborative, iterative, and social in

computer classrooms as compared with paper-and-pencil environments. The results of the meta-analyses suggest that students who use computers when learning to write are not only more engaged and motivated in their writing, but they also produce written work that is of greater length and higher quality.

The Maine Learning Technology Initiative (MLTI) provided laptop computers to all seventh grade students and their teachers in Maine beginning with the 2002-03 school-year. Near the end of the first year of implementation, all special education teachers with seventh grade students were surveyed regarding laptop use by special education students (Harris & Smith, 2004). Students were found to use their laptop computers most frequently for word processing and finding information. Most special education teachers perceived that students with disabilities gain significant benefit from the use of laptop computers. These benefits include improved writing, organization, motivation and self-esteem. In a study that compared the scores of Maine 8th graders on the Maine Education Assessment, researchers found significant increases in writing scores, however, math scores were unchanged, science scores rose by 2 points, and reading scores dropped by 3 points (Sharp, 2007). According to the article, Maine State Commissioner of Education Sue Gendron said it represents the first concrete evidence of what most educators already feel: The laptop program, known as the Maine Learning Technology Initiative, is working.

The Laptop Immersion Program at Harvest Park Middle School in Pleasanton, California was studied to determine the effect of laptops on student learning and achievement (Gulek & Demitras, 2005). The study was conducted at the conclusion of the third year, 2004-05 school-year, of the program. As indicators of student learning, the researchers examined the impact on grade point averages, end-of-course grades, writing skills, standardized achievement test scores, and California standards tests. The findings of the study include the following:

- Laptop students obtained higher grade point averages than did non laptop students.
- Laptop students in general obtained higher end-of-course grades than did non laptop students.
- More laptop students met or exceeded expectations on the district writing assessment than did non laptop students.
- More laptop students scored above the average on a standardized achievement test than did non laptop students.
- A considerably higher percentage of laptop students met or exceeded state content standard expectations for language arts and mathematics than did non laptop students.

The results of the study may have been impacted by two factors. Teachers participating in the laptop program were volunteers and not selected at random. In addition, students in the program were not chosen at random from the population, but had to choose with their parents to participate in the program. Consequently, it is possible that the achievement gains found in the study may be due in part to factors other than participation in the laptop program.

The Northeast and the Islands Regional Technology in Education Consortium reviewed lessons learned to date from many laptop initiatives around the country and prepared a guide for schools or districts as they consider adopting one-to-one learning environments (Bonifaz & Zucker, 2004). The study suggests that over the long term, as computers are used more routinely, changes may take place not only in instruction but also in assessment systems, instructional materials, management systems, and communications. This would imply that changes in student learning would occur over a longer period of time as instruction, assessment, instructional materials, and communications change.

Special Learners Included through Computers in Education (SLICE) is a computerized educational system that allows printed text to be converted into electronic text, and then spoken

aloud by a computer (Strebinsky, 2003). The system was developed in 1995 to support learners from around the country who have difficulty with written language. The purpose of the study was to conduct an objective evaluation of the effects of SLICE in raising student achievement as measured by SAT-9 Total Reading subtest. The context of the study was two schools serving Native American students from the Navajo Nation during the 2000-01 and 2001-02 school-years. The researcher found the following results in the study:

- SLICE students had significantly higher gain scores in achievement than did control students.
- Lower achieving students gained more in terms of achievement than high achieving students for both SLICE and control groups.
- Younger students appeared to have larger achievement gains in both groups.
- The students who participated for a longer time in SLICE showed higher achievement gains.

Students in the study were not randomly selected or matched for participation in groups, so the results of the study may be attributed to factors other than inclusion in the SLICE program.

The initial phase of the Maine Learning Technology Initiative (2002-2004) provided all 7th and 8th grade students and their teachers with laptop computers (Silvernail & Lane, 2004). Schools and teachers were also provided with technical assistance and professional development for integrating laptop technology into their curriculum and instruction. Evidence collected from this study related to student learning included the following:

- Students report using the laptops most frequently in finding information, organizing information, and taking class notes.
- Student usage of the laptops for completing school work is higher for students who take the laptops home.

- Teachers reported that students are more engaged in their learning, more actively involved in their own learning, and produce better quality work.
- Students reported that the laptops helped them to be better organized, complete their school work quicker, and with better quality.
- Teachers reported that all students, particularly at-risk and students with special needs, are more engaged in learning and more motivated to learn.
- A sample of ninth grade students who no longer have laptops reported that they get less school work done without the laptops, and the quality of their school work has declined without the laptops.
- Teachers and principals reported anecdotal evidence that laptops have had a positive impact on student attendance, behavior, and achievement.

The study used surveys to collect perceptual data from various groups involved with the laptop adoption. The study lacks quantitative data that verifies the perceptions of students and teachers involved in study. Consequently, the findings of this study are positive indicators of improved student learning, but the findings may be limited because they can not be collaborated with quantitative data.

All students, 285 students in grades 9 -12, and teachers at Piscataquis Community High School (PCHS) in Maine received laptop computers to use at school and home in 2002 (One-to-One Laptops in a High, 2004). PCHS became one of the demonstration schools for the Maine Learning Technology Initiative. Among the findings of the study related to student learning include the following:

- Most students agreed that laptops make schoolwork more interesting and they are more motivated to do their schoolwork.

- Teachers reported that laptops have improved student engagement, interest in school, and motivation.
- The daily attendance rate at PCHS improved from 91% before laptops to over 98% since the beginning of the program.
- Parents reported that their children are more motivated to learn and that students' level of interest in classes has improved since the beginning of the laptop program.
- Most students agreed that laptops have improved the quality of their schoolwork and improved their grades.
- Most teachers agreed that student achievement and quality of student work has improved in their classes since the laptops program began, especially for students the school defined as at-risk or low-achieving.

While students, teachers, and parents gave positive reports of the effects of the one-to-one laptop program on student learning, the study did not produce any quantitative data to verify or confirm these results.

Athens Academy, a private school located in Athens, Georgia, has been a center of innovation for the integration of technology and media into the classroom since 1990 (Hill, Reeves, Grant, & Wang, n.d.). The laptop adoption began in the 1999-2000 school-year. The study included the following research questions that addressed student learning and achievement included the following:

- Are there differences in the processes of learning that can be attributed to the ubiquitous computing environment?
- How much is learned in English, History/Geography, Math, and Science that can be attributed to the ubiquitous computing environment?

- Are there differences in cognitive skills that can be attributed to the ubiquitous computing environment?
- Are there differences in media literacy skills that can be attributed to the ubiquitous computing environment?

The findings of the study, after 2 years of implementing a one-to-one environment with laptop computers, included the following results:

- There were no differences in the processes of learning that can be attributed to the laptops.
- There was little or no evidence of quantitative differences in achievement and learning performance that could be directly attributed to the use of laptops.
- There is little or no evident that changes in cognitive skills .
- There is some evidence to suggest that students are thinking differently about how to use information sources for learning.

The overall results of this study demonstrate few effects in terms of achievement and performance related to the use of laptop usage. However, the researchers did find generally positive attitudes toward one-to-one computing environments among both students and teachers and believe that these positive attitudes will eventually impact on student achievement and performance in school.

The West Virginia Basic Skills/Computer Education (BS/CE) program began with the kindergarten class of 1990-91 (Mann, Shakeshaft, Becker, & Kottkamp, 1999). Each kindergarten classroom was provided with three to four computers, a printer, and a school-wide, networked file server. Software that focused on the state's basic skills goals in reading, language arts, and mathematics, as well as staff development for teachers on the hardware and software, was also provided to each school. The deployment of computers, software, and staff development was expanded by one grade each year to follow the kindergarten class of 1990-91. This study examined

the Stanford-9 achievement test scores of fifth grade students from 18 elementary schools in the 1996-97 school year. The researchers found that the BS/CE program accounts for 11% of the total variance in the achievement test gains at a .001 confidence level. The researchers believed that the 11% gain attributed to the BS/CE program was underestimated and may actually account for more of the gain. The researchers also determined that the program narrowed the “Digital Divide” between students. Student who had a computer at home (62%) were compared that those that did not have a computer at home (38%). Those without computers at home gained more in the following achievement areas:

- total basic skills
- total language
- language expression
- total reading
- reading comprehension
- vocabulary

In comparing other groups, the study found no difference in gain scores between white and non-white students. In terms of gender differences, only two areas of difference in gain scores emerged in the study. Girls gained more in social studies and boys gained more in spelling. Consequently, the program appears to have leveled the playing field for different groups of students.

Researchers at Carnegie Mellon University found that the use of laptops with college students significantly changed students' work habits, but not always for the better (Sloss & Potts, 2006). All laptop students involved in the study, chosen from the University's School of Design, were given laptops to use at school and at home. The findings of the study include:

- Laptop students spent more time on assignments and worked for longer periods of time than non-laptop students.

- While laptop students spent more time on their assignments, this did not translate into higher quality work. Laptop students often interrupted their work to check e-mail and to surf the internet, or they spent significant time searching the internet for pictures or diagrams they could have created more quickly themselves.
- Laptop students were more likely to work from home and reported home as their preferred place to work.
- Laptop students with laptops were more likely to work alone than other students.

The results of the study were seen as isolating students and not having a positive impact on student performance in the classroom.

New York City Schools began planning for its first adoption of one-to-one computing in the spring of 2004 (*One-to-One in Ten: A One*, 2005). Seven middle schools were identified to participate in the program. The goals of the program were the following:

- Increase the engagement of students in their schoolwork;
- Lower rates of absenteeism and decrease disciplinary problems,
- Teach 21st Century literacy skills--the new learning, communicating, and thinking skills of the Information Age--as well as general technology skills;
- Develop the teaching skills of participating teachers;
- Increase parental involvement and satisfaction; and,
- Improve student achievement, particularly literacy, across all core curriculum areas as demonstrated in a significant rise in standardized test scores.

The majority of goals focus on increasing student learning and engagement of students in their work at school. Success for students was to be measured by standardized test scores, attendance, and behavior problems.

The Union City School District in New Jersey committed to a three year, one-to-one program with laptops at Union Hill High School (Light, McDermott, & Honey, 2002). The program became known as Project Hiller with approximately 70 teachers and 110 students participating in the program. One of the stated goals of the programs was to “increase student performance and outcomes on traditional measures as well as on more authentic measures such as students’ multimedia project presentations.” Students participating in the program had to meet certain requirements to remain eligible. Students in the program agreed to:

- maintain good attendance
- maintain good grades
- work enthusiastically with teachers and students on projects
- attend before- and after-school meetings
- create two PowerPoint presentations in the academic field of their choice

The study gathered information for the three years of the project and used research methodology that combined quantitative methods with qualitative strategies. Findings from the study revealed increased standardized test scores for all groups of students participating in the study compared to their peers. Participants for the study were not selected at random from the school population, but needed to apply to the program. All participants joined the project as ninth graders. Fifty percent of the participants were from the honors program, with priority given to students in the most number of honors classes, with the remainder from the rest of the ninth grade student population. The researchers attempted to match the comparison groups as closely as possible, but the fact that the participants were not selected at random creates the possibility that the results of this study are due in part to factors other than participation in the program.

Promotional Materials Distributed by Computer Vendors

A variety of computer hardware vendors distribute brochures, pamphlets, and other promotional materials designed to market computers and one-to-one learning environments to educators, administrators, and school boards of K-12 schools. This section will examine a number of the promotional materials distributed by these computer hardware vendors. Vendors included in the review are Apple, Dell, Gateway, IBM, and Toshiba. While there may be other computer hardware vendors marketing one-to-one computing environments to schools, these companies appear to currently have the largest share of the market.

Apple Computer produced a white paper to present reasons for schools to consider adopting one-to-one environments (Metiri Group, 2006). The goals for one-to-one learning are presented in the paper as the following:

“Different schools implement 1 to 1 learning for different reasons. In general, the goals driving most 1 to 1 computing initiatives fall into four categories:

- Improving Student Achievement
- Advancing Digital Equity
- Enhancing Teaching and Learning
- Strengthening Economic Development”

The paper also qualifies these goals by stating, “While educators often cite goals other than student achievement, the formal evaluation of such projects is often based entirely on gains in test scores.”

Harvest Park Middle School, located in Pleasanton Unified School District in California, is provided as the example of a school where a rigorous research study has shown increased academic achievement because of a one-to-one environment. The Laptop Immersion Program at Harvest Park Middle School did find increased student achievement on tests, however the selection of students and teachers to participate in the program was not a random process (Gulek & Demitras, 2005).

Consequently, the results of the study may have been influenced by factors other than participation in

the laptop program. Descriptive studies from Peace River North School District in Canada, State of Maine middle schools, Irving Elementary School in Pennsylvania, and Pleasanton Unified School District in California are also presented in the paper. While these studies are not definitive, they do suggest a relationship between one-to-one computing environments and increased student learning and test scores. According to the document, increased student engagement in learning may be the most frequently mentioned teaching and learning goal for implementing a one-to-one computing environment. Examples from Manatee County School District in Florida and School Administrative District #4 in Maine are cited as models where student engagement in learning has increased and is being measured through increased attendance and decreased behavioral referrals.

An earlier marketing paper produced by Apple (Apple Computer, Inc., 2005) found the goals driving most one-to-one adoptions to be the same as presented in the most recent Apple research document on one-to-one computing (Metiri Group, 2006). The 2005 research also found that students use laptops primarily for writing, taking notes, completing homework assignments, keeping organized, communicating with peers and their teachers, and researching topics on the Internet. In this document, Apple recognized the lack of rigorous research regarding one-to-one learning environments. The document states, "In our review, we found few studies that presented research-based evidence of any kind that could help determine how effective 1 to 1 initiatives really are. Only a single study used an experimental design to randomly assign teachers or students to treatment and comparison groups. That study used non-standard statistical techniques to analyze the data and did not identify whether classrooms or students was the unit of analysis; it was therefore not included in our synthesis." Research to support the impact of one-to-one learning is obviously non-existent, or Apple would be using the research to make a strong case for the adoption of one-to-one computing environments.

Apple Computer, Inc. has an internet site that focuses on marketing one-to-one learning environments. One of the documents available on this web site presents the impact and results of

implementing a one-to-one computing environment on student learning (Apple Computer, Inc., 2006). In this document, Apple states that research studies have shown that higher levels of technology access for students will result in higher motivation levels, increased student engagement in learning, higher attendance rates, fewer discipline issues, and overall improved academic performance. The document also provides the reader with eleven examples of increased student learning because of a one-to-one learning environment.

Gateway, another leading computer hardware vendor marketing one-to-one adoptions, makes no claims for improving test scores, raising attendance rates, reducing behavior referrals, or any other indicator of academic learning in its marketing paper on one-to-one initiatives (Center for Digital Education, 2004). Gateway suggests that schools may want to implement a one-to-one computing environment to improve the in-class educational experience for students, provide universal internet access to disadvantaged homes, and build stronger connections between teacher and parent, as well as school and community. The document does make a claim that one-to-one computing enhances twenty-first century learning skills that facilitates learning comprehension through access to interactive resources and mirrors what skills students will be expected to have upon entering postsecondary education or the workforce. Gateway highlights several schools, Watertown High School in South Dakota, Brownell-Talbot in Nebraska, Shattuck St. Mary's in Minnesota, and Houston County Schools in Georgia, that have adopted one-to-one environments. The document also provides school decision makers with tips and suggestions for planning and implementing a one-to-one environment.

Gateway's most recent document marketing one-to-one environments to K-12 schools (Center for Digital Education, 2005) makes more of a case for increased student learning and achievement. According to the examples cited by Gateway in the document, one-to-one computing helps to improve student attendance, to increase student motivation to complete schoolwork, to increase student scores on statewide assessments and standardized achievement tests, to reduce

behavior referrals, to improve writing skills, to improve communication, to make a positive impact on student engagement and interest in school, and to develop twenty-first century learning skills. Numerous schools from across the country are cited in the document. The document also presents ideas to budgeting, planning, and implementing one-to-one environments in K-12 schools.

Toshiba America Information Systems was involved in producing a document describing a pilot laptop program sponsored jointly by Microsoft Corporation and Toshiba America Information Systems (ROCKMAN ET AL, 1997). During the 1996-97 school year, twenty-six private schools and public school districts, including a total of fifty-three different school sites, participated in a program where all students in a classroom, grade level, or a school were provided a laptop. The schools were referred to as “pioneer” schools. Researchers used surveys, telephone interviews, and site visits. Results published in the document include:

- positive changes in student attitudes, motivation, and behavior
- increased student collaboration
- greater student enthusiasm for learning
- more student engagement in problem solving
- improved student writing
- improved presentation and organization skills
- more student active participation in the learning
- increased student responsibility

Results of this study were based on the perceptions of the participants and not supported by any quantitative data or study.

Researchers tracked the experiences of teachers and students at selected “pioneer” schools during their second year of the program as well (ROCKMAN ET AL, 1998). This study was again sponsored by Microsoft Corporation and Toshiba America Information Systems. The second year

study explored computer's impact on teaching and learning among other things. Findings related to student learning include the following:

- Laptop students spend more time using computers.
- Laptops appear to extend the school day.
- More computer use results in more proficient students.
- Laptop students spend more time engaged in collaborative work than non-laptop students.
- Laptop students participate in more project-based instruction.
- Laptop use leads to more writing and to writing of higher quality.
- Laptops increase access to information and improve research and analysis skills.
- Laptop students prepare more presentations than non-laptop students.
- Laptop students direct their own learning more than non-laptop students.
- Laptop students report a greater reliance on active learning strategies.
- Laptop students use computers to accomplish complex school tasks.
- Laptop students readily engage in problem solving and critical thinking.
- Teachers attribute students' critical thinking skills and problem-solving proficiency to the use of laptops.
- Teachers believe laptops benefit students' learning by increasing the quality of student' work , increasing students' interest in school, and by increasing student' learning/understanding of content.

The researchers did not address student achievement in the study. While many measures of student learning were found to be improved in one-to-one environment classrooms, it is not clear from the study what effects this may have on student achievement.

IBM maintains a web site addressing the issues related to one-to-one computing environments (IBM, n.d.a). On the Executive summary tab, IBM lists the reasons why school districts may want to consider one-to-one computing solutions. The reasons listed by IBM are:

- Keep students engaged and provide excitement in learning with interactive, experiential learning.
- Help students learn quickly, taking responsibility for their own learning.
- Provide digitized learning content and access to online learning resources.
- Simplify teachers' lives—provide them with extensive ongoing development and methods for increasing professional productivity.
- Offer flexibility in the time, place and pace of instruction. Improve collaboration and interaction between teachers, students and parents.
- Maximize the use of technology and decrease the need for student textbooks.
- More effectively integrate state learning standards, lesson plans and electronic textbooks into the classroom.
- Allow for effective financial management with bundled, annual per student cost.

While none of these reasons addresses increasing student achievement directly, that may be implied by “keep students engaged...” and “help students learn quickly...”.

IBM’s website related to one-to-one computing lists additional reasons for implementing one-to-one computing under the Business view tab (IBM, n.d.b). IBM refers to “expanding their (students) learning horizons and achieving the highest level of academic performance” by using the IBM one-to-one computing solution. Benefits of one-to-one computing listed on the web page are the following:

- Add depth to your curriculum with extended learning opportunities and multimedia learning.
- Increase teacher interaction with student and parent access to teachers through e-mail.
- Improve academic performance, motivation and independence.
- Level the playing field with computer connectivity at home and school, providing every child with the potential to achieve.
- Raise teacher effectiveness with easier access to up-to-date instructional content, assessment data and individualized instruction.
- Support professional productivity by minimizing the time it takes to perform administrative tasks.
- Advance collaboration among the teaching community.
- Encourage self-directed learning by students.

While IBM states that they have proven experience in providing one-to-one computing solutions in Lausanne Collegiate School in Tennessee, Clovis Unified School District in California, and Wake County Public Schools in North Carolina, the web site presents no research to verify or confirm the effects of one-to-one computing on student learning.

Dell Computer begins one of its marketing brochures with the following, “If there is any innovation that has the ability to change the way that kids can learn and teachers can teach, it’s the computer. Computers can empower faculty, staff and students with 21st century skills and provide a foundation for success in their education and careers” (Dell Computer, 2003). Dell provides a variety of documents and brochures on its web site, <http://www.dell.com/>, including a white paper on one-to-one computing environments that was produced by chip manufacturer

Intel Corporation. According to Intel's white paper (Intel Corporation, 2004) the behavioral benefits of one-to-one computing are the following:

- students spending more time on homework and coming to class better prepared
- parents becoming more involved with their children's education
- teachers reporting that they can more effectively prepare lesson plans, meet their curriculum goals and individualize the curriculum

In addition, these behavioral changes lead to educational benefits found in pilot studies and early deployments that include the following:

- more students continuing their education after high school
- higher scores on state-wide standardized tests
- higher attendance rates and graduation rates
- improvements in writing skills and higher order thinking

Dell's documents include a variety of case studies of schools that have adopted various computer related technologies in schools and classrooms (Dell Computer, 2004) (Dell Computer, 2006a) (Dell Computer, 2006b) (Dell Computer, 2006c) (Dell Computer, 2006d) (Dell Computer, 2006e) (Dell Computer, 2006f) (Dell Computer, 2006g) (Dell Computer, 2007) (Dell Computer, n.d.) . While Dell claims "high student achievement" (Dell Computer, 2004), "marked increase in student writing projects, group work, and student research" (Dell Computer, 2006f), "creates a better learning environment for high school students" (Dell Computer, 2006b), "students have become empowered" (Dell Computer, 2006a), "classrooms are changing student performance and comprehension" (Dell Computer, 2006d), "offer students the best possible education in the midst of fast growth and change" (Dell Computer, 2007), and "technology is a growing part of

providing students with skills for success” (Dell Computer, 2006g), the company does not provide any research to back up its marketing claims.

Summary

Creating one-to-one computing environments is a phenomena that has recently emerged in K-12 schools. Computer hardware vendors have created a variety of promotional and marketing brochures, documents, and papers that expound the benefits of implementing one-to-one computing environments. While some of the promotional materials present research to support the vendor’s claims, many of the materials provide no such research. Much of the research on the effects of computers on student learning is based on surveys and the perceptions of students, teachers, administrators, and parents and not on quantitative data. A small number of the research studies on effects of computers on student learning do provide quantitative data, however, most of the studies did not randomly assign students so the results may be influenced by factors other than participation in one-to-one programs. Many of the research studies report increased student engagement in learning. By definition, student engagement includes a psychological commitment that is difficult to measure. The research primarily uses secondary measures of engagement such as attendance, grades, test scores, and behavioral referrals.

Chapter Three

Methods

The purpose of this study was to describe how the implementation of one-to-one computing environments in high schools influenced teaching and learning. A multiple-site case study design was used for the project. For the purposes of this study, a one-to-one computing environment was defined as a high school where all students and faculty members have been given a laptop computer to use for the school year, twenty-four hours a day, seven days per week, and where a wireless network has been installed in the school so that all laptop computers may connect to the network at any time. Three Midwestern high schools located in different cities and states were included in the study. Each of the high schools implemented a one-to-one computing environment for four or more school years.

Research Design

A multiple-site case study design was used for this study. Creswell defined a case study as where the researcher explores a single entity or phenomenon bounded by time and activity, and collects detailed information by using a variety of data collection procedures during a sustained period of time (Creswell, 1994a). Similarly, Stake states that a case study is the study of the particularity and complexity of a single case, coming to understand its activity within important circumstances (Stake, 1995). The case in this study is the implementation of a one-to-one computing environment in a high school. Three sites, high schools from three different cities and states, are included in the study.

Researcher's Role

The researcher was the only interviewer involved in gathering the data for the study. My perceptions of high school education have been molded by personal experiences in K-12

education. For four years, I was a junior high school math teacher in a large, urban school district. From 1979 until 2006, I served as a principal for five schools of varying size and demographics. My experiences as a principal included all K-12 grades. Since 2006 I have been the Director of Curriculum and Assessment for a large, rural school district in the Midwest. Since I have worked with teachers, principals, superintendents, and boards of education on issues related to curriculum, instruction, student learning, and technology, I bring an understanding of the issues helpful to this study. Although I have made every effort to ensure my objectivity, I bring certain biases to the study. I began this study with the thought that one-to-one computing is a difficult, expensive, and complex program to implement. I also came to the study with the perception that one-to-one computing has a positive impact on teaching and learning, although this may not be evidenced by increased scores on conventional, norm-referenced assessments.

Context for the Study

The context for this study was three Midwestern high schools located in different cities and different states. Each school was chosen by the researcher from his personal professional knowledge of one-to-one adoptions in the Midwest. Schools of different sizes, different locations, and different computer platforms were purposely chosen to participate. An administrator in each district was contacted to explain the research project and to invite the school to participate. All schools invited to participate chose to be involved in the research project. The demographics of each school varied widely from each other. The demographics for each school are listed in Tables 11, 12, and 13. Pseudonyms are used to disguise the identity of each school.

Table 11

Demographics of Schools Included in the Study

School	Enrollment	Attendance % (District)	Free/Reduced Lunch % (District)	Special Needs % (District)
Lake HS	1250	95.1	34.6	13.3
Plains HS	176	94.8	24.4	11.3
Riverside HS	2118	95.7	20.5	10.0

Table 12

Enrollment by Race/Ethnicity

School	% White	% Hispanic	% African American	% Other
Lake HS	95.4	1.3	0.0	3.3
Plains HS	88.6	3.4	0.0	8.0
Riverside HS	86.8	3.4	5.5	4.3

Table 13

American College Test (ACT) Performance

School	English	Math	Reading	Science	Composite
Lake HS	21.5	21.9	22.4	22.5	22.3
Plains HS	19.2	20.1	20.1	20.1	20.1
Riverside HS	23.6	23.4	24.1	23.5	24.7

Each of the schools included in the study has adopted a one-to-one computing environment that has been implemented for at least four years. Each school has a wireless network to support the implementation. Students in each of these buildings are allowed to carry their laptop with them

during the school day and to take the laptop home during evenings and on weekends. Teachers in each of these buildings are also issued laptop computers to use in school and at home. Two of the schools are using Macintosh laptops, while the third school uses a Windows-based computer.

Each school was located in communities that were uniquely different from each other. Lake HS was the only high school in a community of approximately 20,000 residents. Plains HS was located in a small farming community of about 1530 residents located approximately 20 miles from a large metropolitan community. Riverside HS was a suburban school located in a large metropolitan area. Each high school was located in a different Midwestern state; Kansas, Nebraska, and South Dakota.

Data Collection Procedures

All school administrators in each of the participating high schools were invited to take part in an interview regarding their perceptions of the impact of a one-to-one computing environment on teaching and learning. Administrators were also asked how their jobs have changed since the implementation of one-to-one computing. In addition, administrators were asked to identify teachers who have embraced one-to-one computing and have changed their teaching methodologies since one-to-one computing was introduced in the building. In one school, Riverside High School, the administration did not allow the researcher to ask administrators to identify teachers for participation in the study. At Riverside, the principal sent an e-mail to all teachers and asked for volunteer teachers to participate in the study.

A list of teachers recommended by their administrators for inclusion in the study, or volunteer teachers in the case of Riverside High School, was compiled. All teachers on the list were invited to participate in the study. Four to eight teachers from each building, all teachers on the compiled list, agreed to participate and were interviewed for the study. Teachers were asked

about the changes they have seen in student learning and how their teaching methodologies have changed since the implementation of the one-to-one computing environment. The interviews were conducted face-to-face in each of the participants' school. Interviews were used to gain a historical perspective of how teaching and learning has changed since the implementation of one-to-one computing. A total of twenty-nine interviews were conducted. Of these twenty-nine interviews, ten were administrators and nineteen were teachers. Table 14 shows the distribution of interviews in each building. The researcher typed each interviewee's responses during the course of the interview. The typed notes were then e-mailed to interview participants approximately one week after the interview. Interviewees were asked to review the notes and make changes as necessary. Four interviewees, 13.8% of the total, submitted changes to the notes that were e-mailed. Three of the changes were from teachers, and one was from an administrator. Two of the changes came from Plains HS, while one each was received from Lake HS and Riverside HS.

Table 14

Interviews Conducted

School	Administrators	Teachers
Lake HS	3	8
Plains HS	3	7
Riverside HS	4	4

Research Questions

The grand tour research question posed by this study was: How has teaching and learning changed in a high school that has adopted a one-to-one computing environment? Sub questions that were also addressed include the following:

- How has the one-to-one computing environment changed how students learn?
- How has the one-to-one computing environment changed the way teachers teach?
- How has the role of school administrators changed in a one-to-one learning environment?
- How has student' engagement in the learning changed in a one-to-one environment?

External Validity

One threat to external validity is population validity. Some may argue that the schools selected for this study are unique and so different from most schools that results of this study are not applicable to other schools. While the selected schools are certainly high performing schools as measured by a variety of factors, it may in fact be more difficult to increase student learning at these schools than in lower performing schools. Since students at each of these schools already perform at a high level, the opportunity to increase learning is smaller than in many other schools. Another potential threat to external validity is the novelty and disruption effect. While this may have been a factor early in the adoption of one-to-one computing environments in each building, it is unlikely that this effect would have a significant influence on student performance over the course of four or more school years.

Internal Validity

Internal validity has to do with the accuracy of the information collected during the interviews and whether or not it matches the reality of the situation (Creswell, 1994b). To increase the internal validity, all interviews were conducted face-to-face in the respondents'

school. In addition, all interview participants were given an opportunity to review the interview notes and make any changes as they desired. The interviews were also coded based on themes identified by computer hardware vendors in literature promoting the adoption of one-to-one computing environments. These themes are based on perceptions and research gathered by the vendors from teachers, students, and administrators in schools that have implemented one-to-one computing. These procedures were incorporated to increase the internal validity of the study.

Data Analysis

The data analysis included the following steps:

- The literature distributed by computer hardware vendors that promotes the implementation of one-to-one computing was reviewed. Vendor claims for the effects on teaching and student learning was identified and categorized. The themes identified in this literature provided the codes used in the analysis of the interview data. Seventeen themes were identified that related to the effects on student learning. Sixteen themes were identified that related to the effects on teaching and instruction.
- Teacher and administrator interviews were analyzed and coded based on the themes identified from literature distributed by computer hardware vendors that promote the adoption of one-to-one computing environments. The response to each interview question was analyzed and coded based on the identified themes. Most responses contained multiple themes related to student learning and/or instruction. An Excel spreadsheet was used to count the codes referenced by each of the interviewees.
- Matrices of the coded interview responses were developed to present the information systematically.

- A descriptive narrative of themes, patterns, and responses based on teacher and administrator interviews related to one-to-one computing was developed.

Limitations of the Study

The primary weakness of the study is that it focuses on the implementation of a one-to-one computing environment in a limited number of high schools. The study also made no attempt to measure the level or degree to which the adoption had been implemented. In addition, the information gathered during the study is limited by the participants and their perceptions. It is also possible that the presence of the researcher may have biased the participants' responses to the interview questions. However, the results of this study will provide evidence to which areas of teaching and student learning may or may not be affected by the implementation of a one-to-one computing environment that may be generalized to similar situations.

Summary of the Methods

Three Midwestern high schools that adopted one-to-one computing environments were invited to participate in the research project. All school administrators in each high school were invited to be included in an interview regarding their perceptions of the impact of a one-to-one computing environment on teaching and learning. Administrators were also asked how their jobs have changed since the implementation of one-to-one computing. In addition, administrators were asked to identify teachers who have embraced one-to-one computing and have changed their teaching methodologies since one-to-one computing was introduced in the building. In one school, Riverside High School, the administration did not allow the researcher to ask administrators to identify teachers for participation in the study. At Riverside, the principal sent an e-mail to all teachers and asked for volunteer teachers to participate in the study.

A list of teachers recommended by their administrator for inclusion in the study, or volunteer teachers in the case of Riverside High School, was compiled. All teachers on the list were invited to participate in the study. Four to eight teachers from each building, all teachers on the compiled list, agreed to participate and were interviewed for the study. Teachers were asked about the changes they have seen in student learning and how their teaching methodologies have changed since the implementation of the one-to-one computing environment.

The literature provided by computer hardware vendors used to market one-to-one computing to K-12 schools was reviewed and analyzed. Common themes related to changes in teaching and student learning was identified in the vendor literature. The interviews were then coded based on the themes identified in the vendor literature. Interview data was reduced to matrices for analysis. A descriptive narrative of themes, patterns, and responses based on teacher and administrator interviews related to one-to-one computing was then developed to present the research.

Chapter Four

Findings of the Research

Participants

The interviewees from the three high schools that participated in this study provided an invaluable insight into the effects of one-to-one computing on teaching and learning. The data collected in the interviews were coded based on themes identified in the marketing literature of computer hardware vendors promoting the adoption of one-to-one computing environments. Participants were asked to answer questions on either the teacher or administrator interview. The analysis of responses revealed a variety of common themes even though there were significant differences in locations, size, and demographics of the schools involved in the study. The following table lists the interviewees, their role in the school, and the interview in which they participated.

Table 15

Interview Participants

Participant	Role	Interview
Lake HS		
Alan	Asst. Principal	Administrator
Cheryl	Teacher	Administrator
Dale	Principal	Administrator
Dennis	Asst. Principal	Administrator
Don	One-to-One Coordinator	Teacher
Harlan	Teacher	Teacher
Janet	Media Specialist	Teacher
Ron	Teacher	Teacher
Sharon	Teacher	Teacher
Steve	Teacher	Teacher
Tim	Teacher	Teacher

Plains HS

Brian	Principal	Administrator
Carol	Teacher	Teacher
Dan	Teacher	Teacher
Dot	Teacher	Teacher
Gary	Teacher	Teacher
Greg	Teacher	Teacher
Holly	Curriculum Director	Administrator
Lisa	Teacher	Teacher
Sheila	Teacher	Teacher
Richard	Superintendent	Administrator
Riverside HS		
Deena	Dean of Students	Administrator
Kipp	Asst. Principal	Administrator
Lance	Teacher	Teacher
Mark	Technology Coordinator	Administrator
Roxie	Teacher	Teacher
Sherry	Teacher	Teacher
Tori	Asst. Principal	Administrator
Trent	Teacher	Teacher

The teacher and administrator interviews consisted of ten questions each. One item on the administrator interview asked respondents to identify teachers who are using one-to-one computing in a way that enhances teaching and learning. This item was eliminated from the administrator interview at Riverside HS at the request of the Assistant Superintendent.

Interview Themes

Computer hardware vendors marketing materials were examined to identify the effects of adopting a one-to-one computing environment as claimed by the vendors. The researcher identified seventeen themes in the vendor literature that addressed the effects of one-to-one computing on student learning. Table 16 lists the themes as identified by the researcher.

Table 16

Identified Themes for the Effects of One-to-One Computing on Student Learning

Theme

Improved student achievement
Increased student attendance
Decreased student discipline
Improved student engagement in learning
Improved student writing
Improved student presentation skills
Improved student research skills
Increased proficiency in critical thinking and problem solving skills
Enhanced 21 st century learning skills to prepare students for postsecondary or the workforce
Increased quality of student work
Increased student active participation
Increased student responsibility
Increased student motivation
Increased student collaboration
Increased student interaction and communication with parents, teacher, and other students
Extended student day
Equalized access for all students

In addition to identifying themes related to student learning, the researcher also identified sixteen themes in the vendor literature that addressed the effects of one-to-one computing environments on classroom instruction. The following table lists the themes related to the effects of one-to-one computing on teaching.

Table 17

Identified Themes for the Effects of One-to-One Computing on Teaching

Theme

More active learning strategies

More collaborative group work

More project based instruction

More student presentations

More student research

More writing projects

Ability to individualize and/or differentiate

Better learning environment

Easier access to up-to-date content

Flexibility in the delivery of instruction

Increased collaboration with the teaching community

Improved communication with students and/or parents

Increased professional productivity

Increased use of digitized learning content and/or on-line learning resources

Increased use of multimedia resources

Increased speed of content delivery

Findings

Each of the questions answered by the interviewees was analyzed and coded according to the themes in Tables 16 and 17. Many of the responses given by the respondents were given multiple codes by the researcher. In addition, many of the respondents mentioned the same

theme multiple times through the course of the interview. A theme was counted only once for each respondent. A total of 29 educators, 19 teachers and 10 administrators, participated in the research. Table 18 provides an overview of the coded responses to the student learning themes.

Table 18

Reponses to Student Learning Themes

Theme	Teachers	Administrators	Total
Student achievement	10	5	15
Student attendance	0	1	1
Decreased student discipline	1	2	3
Student engagement	3	3	6
Student writing	2	0	2
Student presentation skills	2	0	2
Student research skills	12	4	16
Critical thinking/problem solving	6	1	7
21st century learning skills	4	3	7
Quality of student work	4	2	6
Student active participation	13	7	20
Student responsibility	11	4	15
Student motivation	19	10	29
Student collaboration	9	3	12
Student communication	10	5	15
Extended student day	6	3	9
Equalized access for all students	6	8	14

Table 19

Responses to Teaching Themes

Theme	Teachers	Administrators	Total
Active learning	11	9	20
Collaborative group work	3	1	4
Project based instruction	8	2	10
Student presentations	3	0	3
Student research	6	0	6
Writing projects	2	9	11
Individualize and/or differentiate	6	2	8
Learning environment	2	2	4
Up-to-date content	7	6	13
Flexibility in instruction	18	8	26
Collaboration with teachers	0	0	0
Communication	10	4	14
Professional productivity	7	0	7
Digitized learning content	15	6	21
Multimedia resources	12	3	15
Speed of content delivery	7	2	9

It is interesting to note that there was one effect that all of the interviewees mentioned during the interview: Increased student motivation. Conversely, there was also one theme that

none of the interviewees referenced during the interviews: Increased collaboration with the teaching community. So, thirty-two of the thirty-three themes were mentioned at least once during the interviews. This supports the claims made by the computer hardware vendors in their marketing materials. While there are differences between teacher and administrator perceptions, and differences between the perceptions of educators in different buildings, there is support for the computer hardware vendors claims. The one theme that was not mentioned, increased collaboration with the teaching community, may not have been mentioned due to the nature of the interviews. The interviews focused on student learning and teaching. Increasing teacher collaboration with the teaching community may not have been seen as a method to increase student learning or improve classroom instruction.

Table 20 shows the top five student learning themes mentioned by teachers that participated in the interviews. Table 21 shows the top five student learning themes given by administrators during the interviews. Increased student motivation was mentioned in every interview and is the top response for both administrators and teachers. Increased student active participation, improved student achievement, and increased student interaction and communication with parents, teachers, and other students are in the top five for both lists. The teachers top five also includes increased student research skills and increased student responsibility. The top five for administrators also included equalization of access for all students.

Improved student achievement made the top five of both teachers and administrators. It is interesting to note that not one respondent equated student achievement with higher test scores on achievement tests or college entrance examinations. Dennis, an Assistant Principal at Lake High School said, “(Laptops) increase student achievement. Student achievement, not

necessarily test scores.” Dennis also identified “challenged students” as the group that is particularly affected by one-to-one computing. According to Dennis, “(We have noticed) achievement gains, especially the challenged students have really been helped (by the laptops).” Richard was also hesitant to claim increased achievement test scores. Richard said, “I can’t make claim of better of test scores.” Over half of the respondents indicated that one-to-one computing improves student achievement. This would indicate that teachers and administrators are observing increased student learning, but not necessarily as measured by norm referenced assessments.

Table 20

Top Five Teacher Reponses to Student Learning Themes

Theme	Teachers	Rank
Student motivation	19	1
Student active participation	13	2
Student research skills	12	3
Student responsibility	11	4
Student achievement	10	5-6 (tie)
Student communication	10	5-6 (tie)

Table 21

Top Five Administrator Reponses to Student Learning Themes

Theme	Administrators	Rank
Student motivation	10	1
Equalized access for all students	8	2

Student active participation	7	3
Student achievement	5	4-5 tie
Student communication	5	4-5 tie

It should not be surprising that all but one of the administrators mentioned equalized access for all students as one of the top five student learning themes. Administrators tend to be concerned with issues such as equal access and leveling the playing field for all students. As Richard stated, “The poorest student has the same opportunity as a more affluent kid. They can take the computer home or use it at school. It evens the playing field.” Leveling the playing field and equal access for all students is mentioned numerous times in the literature as a benefit for adopting one-to-one learning environments. (Center for Digital Education, 2004) (eSchool News staff and wire service reports, a) (eSchool News staff and wire service reports, b) (IBM, n.d.) (Metiri Group, 2006) (U.S. Department of Education, 2000).

Tables 22 and 23 show the top five classroom instruction themes mentioned by teachers and administrators in the course of the interviews. Flexibility in the delivery of instruction, increased use of digitized learning content and on-line learning resources, and more active learning strategies were included in the top five for both teachers and administrators. Teachers also included improved communication with students and parents, and increased use of multimedia resources. The top five for administrators also included more writing projects and easier access to up-to-date content. It is interesting to note that all but one teacher and one administrator mentioned the flexibility in instruction theme. This supports the theory that teachers in one-to-one computing environments have in fact changed their instruction to meet the

needs of their students. Kipp may have said it the best of the participants in regard to flexibility in instruction.

The computer is a tool to expand what they (teachers) teach and how they teach it. It gives teachers more modalities of how they teach information.

Tori's perspective was similar. Tori said, "We have always had strong teachers in this building. Given our staff, it's another way to present information in the classroom. This (one-to-one computing) is not a replacement for teachers or teaching." And as Brian stated "Students have pushed teachers to think about getting to the same point but in a different ways." Teachers also reported significant changes in their instruction. Tim said, "Big change ... (I used a) lot of lecture (before the) workshop ... now, (I use) all projects (and) no lectures."

More active learning strategies by teachers is also in the top five lists for both teachers and administrators. While student engagement in the learning didn't make to the top five list of effects on student learning, an increase in active learning strategies by teachers would seem to indicate an increase of student engagement in the learning. As Gary said, "students seem more engaged". Roxie reflected, "Kids are able to engage in discussion in a very interactive way in the class." Another teacher, Don, commented, "If used right, (laptops do a) much better job of engaging the intellect on a higher level, more than a textbook." Teachers using more active learning strategies would certainly engage students more in the learning and increase student achievement.

It is not surprising that increased use of digitized learning content and on-line learning resources is in the top five of both lists. When teachers and students all have easy access to digitized content, it is easier to incorporate the digitized content into the classroom. As Carol said, "This (having access to laptops) is like having a window to the door. Instead of lecturing for an hour about Mark Twain, (now) we're going to go to this web site about Mark Twain."

Table 22

Top Five Teacher Responses to Teaching Themes

Theme	Teachers	Rank
Flexibility in instruction	18	1
Digitized learning content	15	2
Multimedia resources	12	3
Active learning	11	4
Communication	10	5

Table 23

Top Five Administrator Responses to Teaching Themes

Theme	Administrators	Rank
Active learning	9	1-2 tie
Writing projects	9	1-2 tie
Flexibility in instruction	8	3
Up-to-date content	6	4-5 tie
Digitized learning content	6	4-5 tie

While there are some differences in how teachers and administrators viewed the changes in teaching and learning since the adoption of one-to-one computing, there are certainly as many or more similarities in their responses. Administrators and teachers certainly have different perspectives and biases as they reflect on the effects of one-to-one computing in their buildings.

Building Responses

The top five coded responses by building are displayed in tables 24 through 29. Teachers and administrator responses were combined for these tables. Tables 24 and 25 present data for Lake HS. Tables 26 and 27 contain data from Plains HS, and tables 28 and 29 display data from Riverside HS.

Table 24

Top Five Responses to Student Learning Themes at Lake HS

Theme	Responses	Rank
Student motivation	11	1
Student active participation	8	2
Student research skills	7	3
Student achievement	6	4-5 tie
Student responsibility	6	4-5 tie

Table 25

Top Five Responses to Teaching Themes at Lake HS

Theme	Responses	Rank
Flexibility in instruction	10	1
Digitized learning content	7	2
Active learning	6	3-4-5 tie
Project based instruction	6	3-4-5 tie
Individualize and/or differentiate	6	3-4-5 tie

Table 26

Top Five Responses to Student Learning Themes at Plains HS

Theme	Responses	Rank
Student motivation	10	1
Student collaboration	6	2-3 tie
Student communication	6	2-3 tie
Student achievement	5	4-5 tie
Student research skills	5	4-5 tie

Table 27

Top Five Responses to Teaching Themes at Plains HS

Theme	Responses	Rank
Flexibility in instruction	10	1
Digitized learning content	7	2
Active learning	6	3-4 tie
Up-to-date content	6	3-4 tie
Multimedia resources	5	5

Table 28

Top Five Responses to Student Learning Themes at Riverside HS

Theme	Responses	Rank
Student active participation	8	1-2 tie
Student motivation	8	1-2 tie
Student responsibility	5	3-4-5 tie

Student communication	5	3-4-5 tie
Equalized access for all students	5	3-4-5 tie

Table 29

Top Five Responses to Teaching Themes at Riverside HS

Theme	Responses	Rank
Active learning	8	1
Digitized learning content	7	2
Flexibility in instruction	6	3
Communication	5	4-5 tie
Multimedia resources	5	4-5 tie

One would expect differences in responses from building to building. Each building is unique in its location, demographics, and how the one-to-one adoption was implemented and supported. Each of the buildings has provided different workshops and staff development sessions for their teachers that may have had an effect on the interviewee's responses to the interview questions. For instance, the researcher had a number of comments about project based instruction at Lake HS and very few of these comments at the other two schools. This would lead the researcher to believe that the faculty at Lake HS has either had discussions and/or staff development regarding project based instruction. However, while there are differences from building to building, the themes identified in the buildings are very similar to each other. On the student learning themes, increased student motivation is mentioned in the top five in all three buildings. Five themes are in the top five of two of the schools: student active participation,

student responsibility, student achievement, student research skills, and student communication. Only two themes, student collaboration and equalized access for all students, are in the top five of only one school. On the teaching themes, three themes were in the top five of each of the buildings: flexibility in instruction, digitized learning content, and active learning. One teaching theme was in the top five of two schools: multimedia resources. And, four themes were on the top five for only one school: project based instruction, communication, up-to-date content, and individualize and/or differentiate. On the teaching themes, there is much commonality, yet each building has their unique focus for one-to-one computing.

Chapter Five

Conclusions and Recommendations

Introduction

This study examined the effects of adopting a one-to-one computing environment on teaching and learning in high schools. Twenty-nine teachers and administrators from three, Midwestern high schools were included in the study. The three high schools are of varying size and demographics. Participants in the study were interviewed regarding their perceptions of the effects that one-to-one computing has made on teaching and learning in their school. The grand tour research question posed by this study was: How has teaching and learning changed in a high school that has adopted a one-to-one computing environment? Sub questions that were also addressed include the following:

- How has the one-to-one computing environment changed how students learn?
- How has the one-to-one computing environment changed the way teachers teach?
- How has the role of school administrators changed in a one-to-one learning environment?
- How has student' engagement in the learning changed in a one-to-one environment?

How Has Student Learning Changed?

Each interview participant identified "increased student motivation" as one way that student learning has changed in a one-to-one environment. Increasing the motivation of high students is a significant factor in learning. Motivation has an impact on students' intent to learn, engagement in the learning, achievement, attendance at school, and discipline. If students are more motivated to learn, there is little doubt increased learning will occur. Seventeen themes affecting student learning were identified in the marketing literature published by the computer

hardware vendors on the one-to-one computing. However, student motivation is at the core of the majority of these themes. Roxie made the following comment, “Students are given the opportunity to be teachers at times. For instance, one of my classes has been doing an i-movie. I didn’t know all of the special effects, but some students are masters of the program. It gave students an opportunity to help each other. Having advanced knowledge of program, can be a motivation for students. This allows students to demonstrate their strengths.” Without increasing student motivation, many of the other student learning themes would not be possible to accomplish.

“Increased student active participation” was second on the list of themes most frequently mentioned by interviewees. Teachers and administrators not only observed increased student motivation, but also observed increased active participation of the students. Not only are students more motivated to learn, they are actively participating in the learning. It would appear obvious that students who are more actively participating in the learning are learning more than the passive learners that are too frequently observed in high schools.

The next most frequently identified theme was “increased student research skills”. One-to-one computing puts the power of a computer in the hands of each student. Students have access to almost unlimited resources through networks and the internet. The ease of access, as opposed to moving students to a computer lab, media center, or a college library, promotes the inclusion of more research into the school day. As Steve, a teacher at Lake HS, stated:

(We) used to take debaters to (college) libraries. We would spend thousands of dollars to travel. Now we do research on the computer. (It’s a) whole new world, better. (We have) college libraries at our fingertips.

Carol, a teacher at Plains HS, also talked about student research:

The processes of whatever we're working on are supported by the laptops in the classroom. (The) writing process, research process, reading process. (The) processes are the goals that are the most practical.

So, if teachers are incorporating more research into their classes because of the access provided by one-to-one computing, it's no surprise that student research skills would be affected by the increased instruction in this area.

“Improved student achievement”, “Increased student responsibility”, and “Increased student interaction and communication with parents, teacher, and other students” were the next most frequently identified student learning themes. These themes were tied for fourth, fifth, and sixth in the ranking of most commonly mentioned items by any of the study participants. It's not surprising that teachers and administrators would observe improved student achievement if they are also observing increased student motivation and increased active participation by students in the learning. The interesting observation is that improved student achievement does not necessarily transform into higher scores on achievement tests, college entrance exams, and other norm referenced assessments.

Student responsibility in one-to-one schools could be described in several ways. First of all, students have been given a tool to use twenty-four hours a day, seven days a week that is expensive. Most of the laptops used in one-to-one schools are valued at \$1,000 or more. This is a significant responsibility for an adolescent! Responsibility may also be viewed as a student taking responsibility for his or her own learning. Each student in a one-to-one school has access to an almost unlimited number of resources available on the school's network and the internet. Dot made the following observation during the interview, “(A) lot more of the students take the initiative for learning.” And, there are no excuses, at least legitimate ones, for students not being able to complete their assigned homework or projects. Each of the three schools has provided

students and teachers with on-line textbooks and resources. As Lance stated during his interview, “(There are) no excuses for (students) not benefiting from an (one-to-one computing) environment like that.” and “There are no excuses for not having a book.” One-to-one schools may provide more opportunities for students to be responsible, thus increasing the demonstration of that responsibility as observed by teachers and administrators.

Communication between students, parents, and teachers is an area that can certainly be enhanced by technology. Teachers and administrators in the three high schools were using tools such as e-mail, content management software such as Blackboard and WebCT, and i-chat to increase communication related to school, learning, and teaching. While some of the schools discouraged and blocked communication tools such as i-chat at school, other schools and teachers found this to be an extremely useful tool to communicate with their students. Holly, a school administrator at Plains HS, made the following comment regarding student-teacher communication in a one-to-one environment, “There is instant messaging and email that helps the students and teachers interact on a more personal level.” Dot, a teachers at Plains HS, said “(Laptops) allow students and teachers to relate, students will get on-line and talk about their weekend, confide serious stuff to teachers because no one else is listening.” Dot’s response indicates that students and teachers can build very personal relationships through the use of communication tools on the laptops. Gary, also a teacher at Plains HS, made the following observation, “(Students are) more likely to do an i-chat assignment than find pictures in magazines at home.” Gary’s statement would seem to indicate a link between electronic communication and student interest and motivation to learn. Other teachers and administrators also mentioned the increased access for students and parents to grades and attendance data. Lance had the following insight about communicating with students:

Access to assistance from other students and teachers can't be contained. (Students have) access to me from 7 am to 10 pm. E-mail is different than communicating with a phone call. Answering an e-mail is not like work, but a phone call is (work) and an interruption.

There are certainly many ways for teachers, students, and parents to communicate regarding a wide variety of topics and issues in a one-to-one environment.

How Has Teaching Changed?

A somewhat common theme heard during the interviews, especially from teachers, was that my teaching really hasn't changed; I just have more choices of how to do things in the classroom. Lisa made the following comment, "(I'm) giving notes using the laptop, instead of writing notes on the blackboard." Harlan made the following observations, "Students do power point (presentations). (I) did that before (one-to-one computing), but (it was a) scheduling nightmare." and "Groups of kids select a cartoon. Then you and your partner have to present. I can send that to an lcd projector. Students explain significance of (their) cartoon. (I) did that 20 years ago, but I had to cut (cartoons) out of the paper and make overheads. (Now) kids will get last night's stories that are up to date." Cheryl also made the following comment, "Hasn't changed in the classroom a great deal. (Laptops have) allowed (me) to add things. (I) expect kids to do things at home." Many of these changes have made it easier for teachers to present up-to-date information in their classes and have been motivational factors for students.

While a number of teachers may be using one-to-one technology to teach in a manner similar to the ways they taught before one-to-one computing, there are a number of teachers that have made significant changes in how they teach. Ron, a teacher at Lake HS, commented "(One-to-one computing has) changed (my) philosophy. (I) do very few worksheets, more hands on." Roxie, a teacher at Riverside HS, reflected "It gives me more options. Students are willing to try new things more easily. I assign more and different types of assignments that hit on

different learning styles. (I give) more interactive assignments.” Sherry, another teacher at Riverside HS, said “We do a lot more listening activities. We use the computer for practice instead of worksheets. (Students have) instant feedback. Students can redo work as much as they want for more practice.” Tim, a teacher at Lake HS has been very creative with his use of technology to motivate students. Tim described his unique instructional technique as follows: “(I use computers to do a) different thing for students, a fireplace. (We have a) fireside chat using power points.” Gary, a teacher at Plains HS, uses YouTube videos in his classroom to create interest and motivate students while learning. Gary showed demonstrated a video, Dora the Explora Chola, that he obtained from YouTube and that he uses with his classes.

The theme most identified by teachers and administrators regarding changes to teaching was “flexibility in the delivery of instruction”. One-to-one computing has allowed teachers choices: choices in how to present information, choices in where to find appropriate content, choices in what assignments to give students, choices in how to communicate with students, and choices in how to assess student learning. These choices have given teachers considerable flexibility in their classroom instruction. While this flexibility in the delivery of instruction is beneficial to teachers, it is also beneficial to students. More flexibility in instruction allows teachers to design lessons to better meet the learning needs of their students.

“Increased use of digitized learning content and/or on-line learning resources” was the next mentioned by the most respondents. Riverside HS used Blackboard as the content management software for their teachers and students. A number of teachers at Lake HS were using Web CT in the same manner. Teachers at Plains HS did not mention the use of content management software. Some of the teachers in all of the buildings were using electronic textbooks. The teachers who were using the electronic texts were pleased with the opportunity to

have access to them. As Lance said, "I think the laptops have simplified things to the point that if you have a good (on-line) textbook, kids and teachers have access, teachers have PowerPoints, there are no excuses for not having a book. That is no longer a hindrance on learning because a kid doesn't have a book." Lance also said, "I can use questions as an out of class quiz to monitor student learning." Sherry also commented about her use of electronic textbooks, "Changed a lot! (I) no longer use a textbook in class. Students have a lot more sources to use with the internet and web sites we give them." Teachers in each of the buildings commented about learning materials they had found through the use of the internet. The materials ranged from YouTube videos to documents from college libraries. In one-to-one schools, access to digitized learning materials in the classroom is quick and easy as compared to schools that have not adopted one-to-one computing. In the non one-to-one schools, teachers have to take students to a computer lab to gain access to the digitized materials. And, even in that situation, students only have access for that period of time. All students do not have access outside of their time in the computer lab. When you give teachers and students increased access to digitized materials, it's not surprising that teachers would make more use of these materials in their classes.

"More active learning strategies" was the next most mentioned theme related to changes in teaching. Dot made the following observation about her students, "(There is) always something going on (in the classroom). Students are always working on something, projects, looking up information, long term projects and assignments." Many of the teachers mentioned using more project based instruction and giving students more choices to demonstrate what they had learned. Allowing students to have choices for demonstrating their learning increases their active participation in the classroom. Sherry also said, "(My) methodology has changed, not all teacher dominated, student initiated as well." Sherry's statement would indicate active student

participation in the learning. Teacher dominated classrooms tend to be more passive learning environments; while student initiated learning requires the active participation of students. Several of the teachers mentioned the use of discussion boards to get all students involved. In the past, only a few students would participate in in-class discussions. With the use of discussion boards and similar software, all students can be involved in the discussion and the learning. Steve made the following comment, “A lot more students participate who wouldn’t have participated.” One-to-one computing has given teachers more opportunities to incorporate active learning strategies into their classrooms.

“Increased use of multimedia resources” and “Improved communication with students and/or parents” are the next two most frequently mentioned themes related to teaching changes. The use of multimedia resources is closely related to the use of digitized and on-line content. The ease and level of access to these resources has greatly enhanced their use within the classroom. In schools that have not adopted a one-to-one environment, the use of multimedia resources is much more difficult and tends to become an “event” instead of something that is available at all times. Improved communication was also a frequently mentioned theme for changes in student learning. One-to-one computing gives unlimited access to a variety of communication tools for teachers and students to use. Teachers and administrators in the study reported using communication tools to visit with students and parents about grades, attendance, discipline, assignments, and personal issues. The laptops certainly have the potential to enhance communication between everyone associated with the school.

How has the role of school administrators changed?

The primary focus of this study related to changes in teaching and learning in a one-to-one computing environment. However, I also explored how administrators perceived that their

role had changed since the adoption of one-to-one computing. Most of the administrators perceived that their job had not changed, but that the focus of their job had shifted. Richard's comment was, "My job hasn't changed, just shifted." Tori stated, "It's a different kind of discipline." Brian's comment was "My job hasn't completely changed." Kipp responded by saying, "My job has changed the way I spend my time with computers." However, Deena made the following observations when asked how her job as an administrator had changed:

My job has really changed! The first couple of years were way worse than it is now. We've learned a lot in the process. I've changed as a disciplinarian. I'm teaching discipline now with technology. We're teaching them how clicking the wrong button can change your life. Social networking sites, how colleges and business now check these sites. We have more contact with students talking about these issues than schools with traditional computer labs."

Holly also described how her role changed with the implementation of one-to-one computing:

We were trailblazers. There was no one to call. (We were) blazing our way through the forest to find the meadow. It's exciting to come to school. The district has earned national recognition. On personal level, Holly has had opportunities to speak at conventions and to take students to present (also). (There is) no magic pill. Technology changes so fast that you need to stay on top of your game. It (technology) has to work. My job is to be (a) cheerleader, (to) remove barriers. Kids compete in global world. (That has) changed a lot. (I) need to be organized, need to have a system in place. There is more data to keep track of.

The administrators in the study frequently mentioned spending more time on issues such as computer theft, damage to computers, cyber bullying issues, inappropriate uses of the computers, social networking sites, monitoring student e-mails, keeping up to date on current technologies, encouraging teachers to use technology in their classes, and making sure the technology is available and working for teachers and students. While this list of issues may be similar to issues in all schools, these issues may be amplified in a one-to-one school. None of the administrators commented that would not want to be in a one-to-one computing school. The

administrators at Riverside HS clearly stated their thoughts on the benefits of a one-to-one environment. Kipp made the following comments:

But, I believe it's (one-to-one computing) the way to go. Computers level the playing field. The cost is worth the benefits. Computers propel middle kids ahead. (The) computer is a tool to use to enhance learning.

Tori had the following to say about one-to-one computing:

Really excited about being part of one-to-one! The benefits outweigh the negatives. And, the computer is not an end all. I can't imagine not having computers. Computers have been a plus and added to the classroom.

However, Holly's comments may capture how many administrators perceive one-to-one computing in their buildings.

When one-to-one was first coming out, I thought it was a great benefit for all kids to have a laptop. But it ended up creating more problems for us. Now I have changed back. One-to-one is more beneficial for kids. I am teaching kids the right and wrong ways to use technology. There is no reason to pretend it's not there. To help students make better decisions, we are helping them in that process. A couple years ago I would have said "get rid of these things". Now I believe that the computers are very beneficial.

The role of a school administrator in a one-to-one school may not be much different from that of an administrator in a school that has yet to adopt one-to-one learning. However, the focus of the job may be different and the issues to address may be different. Giving students an expensive piece of hardware and allowing them to access the internet and to communicate twenty-four hours a day, seven days a week, will certainly bring administrative challenges to a school of any size. The administrators in this study clearly stated that the benefits to teaching and learning certainly outweigh any of the negative aspects of a one-to-one computing environment.

How has student' engagement in the learning changed?

Measuring student' engagement in the learning is difficult to measure. According to the Committee on Increasing High School Students' Engagement and Motivation to Learn (Committee on Increasing High School Students' Engagement and Motivation to Learn, Board on Children, Youth, and Families Division of Behavioral and Social Sciences and Education, 2004), engagement involves both behaviors and emotions. According to the Committee, activities that engage students have the following qualities:

- emphasis on high-order thinking
- active participation
- variety
- collaborative activities
- meaningful connections to students' culture and lives outside of school

The top five themes for changes in student learning and teaching as identified in the interviews included active participation. In addition, flexibility in the delivery of instruction implies that teachers are using more variety in their classes. Many teachers also reported that they were giving students more choices on how they demonstrated what had been learning. This would also imply variety. Many teachers also said they were finding material that was more "real world" and interesting to students. This would appear that these educators are making more meaningful connections to students and their lives outside of school. Some teachers also reported using more group and collaborative projects; while others said they were using assignments that required higher-order thinking skills.

Increased student' engagement in the learning was specifically mentioned by six of the twenty-nine respondents, three teachers and three administrators. Two of the five factors that engage students as identified by Committee on Increasing High School Students' Engagement

and Motivation to Learn were frequently mentioned by interviewees in this study. The other three factors, emphasis on high-order thinking, collaborative activities, and meaningful connections to students' culture and lives outside of school, were mentioned, but by fewer of the respondents. One-to-one computing has the potential to increase student' engagement in the learning, and may well increase engagement in learning. However, it would appear that the degree of student engagement is dependent upon the instructional strategies employed by the classroom teacher. Increased student' engagement may not result from the implementation of a one-to-one computing environment. The one-to-one environment may provide the teacher with more tools to engage students in the learning; however, if the teacher does not have the instructional skills, they may not take advantage of the tools provided by the laptops.

Summary

The grand tour research question posed by this study was: How has teaching and learning changed in a high school that has adopted a one-to-one computing environment? This study described how teaching and learning has changed in three Midwestern high schools since their implementation of one-to-one computing environments. From the interview responses, it is clear that student learning and teaching has changed and has been affected in a positive manner in each of these schools. It is also clear that teachers and administrators in these buildings believe the benefits of a one-to-one implementation are well worth the financial cost. While the implementation and transition to a one-to-one environment hasn't always been easy, smooth, and without problems, many of the interviewees stated that they would not want to work in a building that didn't have one-to-one adoption. Teachers and administrators pointed to numerous problems and issues they have had in their buildings that were related in part to one-to-one computing. Some of these include: networks and servers not working, new hardware and

software to install and learn, filtering programs, state control over e-mail and access to the internet, students not using the computers appropriately, cheating, cyber bullying, students being distracted in class by their computer, damaged and broken computers, students playing games, e-mailing, texting, or chatting instead of doing school work, etc. In the end however, teachers and administrators believed that the inconveniences and problems they experienced with one-to-one computing were far outweighed by the benefits for students and teachers. Most respondents stated that the computer was just another tool, albeit a powerful one for teaching and learning, but that it was up to the teacher to use it effectively with their students. Learning how to use the computer to increase active participation, motivation, collaboration, communication, project-based assignments, 21st century learning skills, achievement, etc. is the key. Staff development related to not only how to use the computer, but training on instructional strategies that may be employed in the classroom to enhance learning. Holly, a school administrator at Plains HS, may have summed it up the best with the following comment:

When people came to visit, they come thinking it's about the technology, but when they leave they realize it's more about the teaching and learning and that technology is the catalyst for the change. (That's) what it's about. Technology is the catalyst. The important thing is believing that you're making a difference in the lives of people.

Recommendations for Further Study

One-to-one computing is a relatively new phenomenon in K-12 schools and not well understood by all educators. This study only examined perceptual data provided by the interviewees. No empirical data was collected to quantify the changes described by participants in this study. Over the course of this study, several questions emerged related to the topic of one-to-one computing. While not included within the context of this study, they warrant mention as consideration for future research studies. Possible areas of future study include the following:

- What are the long-term effects of one-to-one computing on students? Are they better learners at post-secondary schools? Do they get jobs that are technology related?
- What is the best implementation model for one-to-one computing? Or, is one-to-one computing so unique that each school will have a different implementation model?
- What instructional skills are the most effective in a one-to-one computing environment? Are there instructional strategies that are good for all teachers, but are enhanced by the use of computers in the classroom? Are colleges of education preparing students for this type of environment?
- Are there differences in the instructional skills of teachers in one-to-one environments as compared to those in more traditional settings?
- Are there differences in student' engagement in the learning when comparing one-to-one schools with schools that have not adopted one-to-one computing? What are those differences? Are they significant?
- Several interviewees said that one-to-one computing speeds up the learning. Is there a difference in the amount of content taught in a one-to-one classroom as opposed a classroom in a building that has not adopted a one-to-one environment?
- Are there differences in academic achievement, attendance rates, and discipline rates when comparing one-to-one schools with schools that have not adopted one-to-one? Are the differences significant?

Larry Cuban questioned one-to-one computing environments in K-12 schools in his article, *1:1 Laptops Transforming Classrooms: Yeah, Sure (1:1 Laptops Transforming, 2006)*. Cuban claims that studies of one-to-one implementations in college classrooms has made few if any marked changes in the instructional strategies used by professors. Are we, as Cuban claims,

“painting a utopian picture of transformed teaching and learning unlike anything that existed before?” If the potential of one-to-one computing is to be unleashed and evidenced by increased learning and effective teaching strategies, researchers need to provide evidence that disproves Cuban’s claims. One-to-one computing is still in its infancy. The challenge will be to provide research proving the effects of one-to-one computing on teaching and learning.

References

- 1:1 Laptops Transforming Classrooms: Yeah, Sure.* (October 31, 2006). Retrieved January 4, 2007, from <http://www.tcrecord.org> ID Number: 12818
- Appel, J.A. (May 1, 2007). *eSchool News online*. [Parents, kids call for more tech use in schools]. Retrieved July 28, 2007, from <http://www.eschoolnews.com/news/showstory.cfm?ArticleID=7040>
- Apple Computer, Inc. (2005, June). *Research: What It Says About 1 to 1 Learning*. Retrieved January 4, 2007, from http://ubiqcomputing.org/Apple_1-to-1_Research.pdf
- Apple Computer, Inc. (2006). *Impact and Results Apple 1 to 1 Learning*. Retrieved September 21, 2006, from <http://www.apple.com/education/k12/onetoone/research.html>
- Baker, E. L., Gearhart, M., & Herman, J. L. (1990). *Apple Classrooms of Tomorrow* (7) [Evaluation Study: First- and Second-Year Findings]. Retrieved February 19, 2007, from <http://164.83.2.51/ACOT%20reports/rpt07.pdf>
- Bonifaz, A., & Zucker, A. (2004). *Lessons Learned About Providing Laptops for All Students*. [A product of the Northeast and the Islands Regional Technology in Education Consortium.]. Retrieved February 23, 2007, from <http://www.neirtec.org/laptop/LaptopLessonsRprt.pdf>
- Brumfield, R. (May 10, 2005). Mich., Ind. mull 1-to-1 computing plans. *eSchool News online*. Retrieved January 6, 2007, from <http://www.eschoolnews.com/news/PFshowstory.cfm?ArticleID=5660>
- Center for Digital Education. (2004). *One-to-One Laptop Initiatives Providing Tools for 21st Century Learners*. [Underwritten by: Gateway]. Retrieved October 2, 2006, from <http://www2.edweek.org/ads/advertorials04/Gateway.pdf>
- Center for Digital Education. (2005). *K-12 One-toOne Computing Handbook A complete resource for policy makers, school boards,superintendents & the K-12 community*.

- [Underwritten by Gateway and the Microsoft Corporation]. Retrieved September 21, 2006, from http://www.gateway.com/work/pdf/edu/K12_1to1_Computing_Handbook.pdf
- CEO Forum on Education and Technology. (2001, June). *Key Building Blocks for Student Achievement in the 21st Century*. Retrieved October 2, 2006, from <http://www.ceoforum.org/downloads/report4.pdf>
- Committee on Increasing High School Students' Engagement and Motivation to Learn, Board on Children, Youth, and Families Division of Behavioral and Social Sciences and Education. (2004). *Engaging Schools: Fostering High School Students' Motivation to Learn*. Washington, D.C.: The National Academies Press.
- Creswell, J. W. (1994). *Research Design: Qualitative & Quantitative Approaches* (p. 12). Thousand Oaks, California: SAGE Publications.
- Creswell, J. W. (1994). *Research Design: Qualitative & Quantitative Approaches* (p. 158). Thousand Oaks, California: SAGE Publications.
- Cuban, L. (October 18, 2006). The Laptop Revolution Has no Clothes. *Education Week*. Retrieved January 6, 2007, from <http://www.edweek.org//ew/articles/2006/10/18/08cuban.h26.html?print=1>
- DaBell, M., & Chapman, C. (2006, September). *Computer and Internet Use by Students in 2003* (NCES 2006-065). Retrieved January 6, 2007, from <http://nces.ed.gov/pubs2006/2006065.pdf>
- Davis, D., Garas, N., Hopstock, P., Kellum, A., & Stephenson, T. (2005, February 10). *Henrico County Public Schools IBook Survey Report*. Retrieved February 22, 2007, from <http://www.henrico.k12.va.us/pdf/technology/hcreport.pdf>
- Dell Computer. (2003). *Integrating technology and learning. How the right partner can be the right next step*. [Brochure]. Retrieved March 5, 2007, from http://www.dell.com/downloads/global/solutions/public/Brochures/resource_411.pdf

- Dell Computer. (2004, July). *Dell K12 Solutions: Springfield Public Schools*. Retrieved March 5, 2007, from
http://www.dell.com/content/topics/topic.aspx/global/shared/sitelets/pub_solutions/k12/resources/case_studies/springfield_public_schools_75?c=us&cs=RC957240&l=en&s=k12
- Dell Computer. (2006). *Bellevue School District: Saving Time. Enhancing Learning*. [Scholastic Case Study]. Retrieved March 4, 2007, from
http://www.dell.com/downloads/global/solutions/public/Case_Studies/992_resource.pdf
- Dell Computer. (2006). *Culver Academies: Winning With Wireless*. [Scholastic Case Study]. Retrieved March 4, 2007, from
http://www.dell.com/downloads/global/solutions/public/Case_Studies/989_resource.pdf
- Dell Computer. (2006). *The Strength of a Good Roadmap*. [Glendale USD and Dell Professional Services drive technology momentum]. Retrieved March 4, 2007, from
http://www.dell.com/downloads/global/solutions/public/case_studies/glendale_usd_case_study.pdf?c=us&cs=RC957240&l=en&s=k12
- Dell Computer. (2006, December). *Revolutionizing Training*. [Dell Learning System helps Oklahoma City Public Schools take training programs further]. Retrieved March 5, 2007, from
http://www.dell.com/downloads/global/solutions/public/articles/oklahoma_city_pub_schls_12_20.pdf?c=us&cs=RC957240&l=en&s=k12
- Dell Computer. (2006). *Roanoke County Public Schools: High-Tech High*. [Scholastic Case Study]. Retrieved March 5, 2007, from
http://www.dell.com/downloads/global/solutions/public/Case_Studies/990_resource.pdf
- Dell Computer. (2006). *Round Rock ISD: Texas Technology*. [Scholastic Case Study]. Retrieved March 5, 2007, from
http://www.dell.com/downloads/global/solutions/public/Case_Studies/993_resource.pdf

- Dell Computer. (2006). *St. Joseph's Academy: Empowering Girls*. [Scholastic Case Study]. Retrieved March 5, 2007, from http://www.dell.com/downloads/global/solutions/public/case_studies/991_resource.pdf
- Dell Computer. (2007, January). *Leveraging Technology for Student Achievement*. Retrieved March 5, 2007, from http://www.dell.com/downloads/global/solutions/public/case_studies/fulton_county.pdf?c=us&cs=RC957240&l=en&s=k12
- Dell Computer. (n.d.). *Dell K12 Solutions: Mobility*. Retrieved March 5, 2007, from http://www.dell.com/content/topics/topic.aspx/global/shared/sitelets/pub_solutions/k12/mobility?c=us&cs=RC957240&l=en&s=k12&~page=2
- Duffy, T. M., & McMahon, T. A. (February 1, 1999). *Linking homes and elementary schools with computers: The impact on pedagogy* (CRLT Technical Report No. 9-99). Retrieved February 10, 2007, from <http://crlt.indiana.edu/publications/workpapers/crlt99-9.pdf>
- eSchool News staff and wire service reports. (September 6, 2006). Digital divide still separates students. *eSchool News online*. Retrieved September 17, 2006, from <http://www.eschoolnews.com/news/PFshowstory.cfm?ArticleID=6576>
- eSchool News staff and wire service reports. (June 1, 2001). Laptops to transform learning for 23,000 Virginia students. *eSchool News online*. Retrieved January 6, 2007, from <http://www.eschoolnews.com/news/PFshowstory.cfm?ArticleID=2637>
- Fryer, W. A. (2004, December). *ASSESSING THE IMPACT OF ONE TO ONE TECHNOLOGY IMMERSION ON STUDENT ATTENDANCE: CHASING SHADOWS OR THE PANACEA FOR EDUCATIONAL REFORM?* Retrieved February 19, 2007, from http://www.wesfryer.com/onetoone/onetoone_attendance.pdf
- *Goldberg, A., Russell, M. (Ed.), & Cook, A. (2003, February). The Effect of Computers on Student Writing: A Meta-analysis of Studies from 1992 to 2002. *Journal of Technology*,

- Learning, and Assessment*, 2(1). Retrieved February 22, 2007, from
http://www.bc.edu/research/intasc/jtla/journal/pdf/v2n1_jtla.pdf
- Gritter, A. (2005, April). *Belief Drives Action: How Teaching Philosophy Affects Technology Use in the Classroom*. Retrieved July 15, 2007, from
http://www.usm.maine.edu/cepare/Reports/Belief_Drives_Action.pdf
- Gulek, J. C., & Demitras, H. (2005, January). Learning With Technology: The Impact of Laptop Use on Student Achievement. *The Journal of Technology, Learning, and Assessment*, 2(2). Retrieved February 23, 2007, from
http://www.bc.edu/research/intasc/jtla/journal/pdf/v3n2_jtla.pdf
- Harris, W. J., & Smith, L. (2004, February). *Laptop Use By Seventh Grade Students with Disabilities: Perceptions of Special Education Teachers* (Research Report #2) [Maine Learning Technology Initiative]. Retrieved February 23, 2007, from
<http://www.usm.maine.edu/cepare/pdf/mlti/MLTI%20Phase%20One%20Evaluation%20Report%202.pdf>
- Hill, J. R., Reeves, T. C., Grant, M., & Wang, S. (n.d.). *THE IMPACT OF PORTABLE TECHNOLOGIES ON TEACHING AND LEARNING: YEAR TWO REPORT*. Retrieved February 23, 2007, from
<http://lpsl.coe.uga.edu/projects/aalaptop/image/PDF/AAYearTwoRpt.pdf>
- Hu, W. (May 4, 2007). Seeing No Progress, Some Schools Drop Laptops. *The New York Times*. Retrieved May 16, 2007, from
<http://www.nytimes.com/2007/05/04/education/04laptop.html?pagewanted=1&ei=5070&en=8e8c03443532b328&ex=1179460800>
- IBM. (n.d.). *1:1 computing solution from IBM*. [Executive summary]. Retrieved March 4, 2007, from <http://www-03.ibm.com/industries/education/doc/content/solution/1342656310.html>
- IBM. (n.d.). *1:1 computing solution from IBM*. [Business view]. Retrieved March 4, 2007, from <http://www-03.ibm.com/industries/education/doc/content/solution/1342656110.html>

- Indiana's TECH-KNOW-Build Project: Linking Laptops and Learning*. (2006, April). Paper presented at Tech Forum Chicago. Retrieved February 17, 2007, from http://rockman.com/publications/presentations/tkb_paper
- Intel Corporation. (2004). *Transforming Education Through Wireless, One-to-One Mobile Computing*. Retrieved March 5, 2007, from http://www.dell.com/downloads/global/solutions/public/White_Papers/resource_737.pdf
- Light, D., McDermott, M., & Honey, M. (2002, May). *THE IMPACT OF UBIQUITOUS PORTABLE TECHNOLOGY ON AN URBAN SCHOOL PROJECT HILLER*. [Center For Children & Technology]. Retrieved March 3, 2007, from <http://www.cct.edc.org/admin/publications/report/Hiller-Final.pdf>
- Mann, D., Shakeshaft, C., Becker, J., & Kottkamp, R. (1999). *West Virginia Story: Achievement gains from a statewide comprehensive instructional technology program*. Retrieved February 24, 2007, from <http://www.mff.org/pubs/ME155.pdf>
- Metiri Group. (2006). *1 to 1 Learning A Review and Analysis by the Metiri Group*. [Apple Computer]. Retrieved September 21, 2006, from http://images.apple.com/education/k12/onetoone/pdf/1_to_1_white_paper.pdf
- Murray, C. (November 1, 2004). Study reveals trends in ed-tech spending. *eSchool News online*. Retrieved January 6, 2007, from <http://www.eschoolnews.com/news/PFshowstory.cfm?ArticleID=5340>
- National Center for Education Statistics, U.S. Department of Commerce, & Census Bureau. (2005, May). *Student use of computers, by level of enrollment, age, and student and school characteristics: 1993, 1997, and 2003* (Table 420). Retrieved September 4, 2006, from http://nces.ed.gov/programs/digest/d05/tables/dt05_420.asp:
- Newmann, F. M. (Ed.). (1992). Introduction. In *Student Engagement and Achievement in American Secondary Schools* (introduction). Retrieved March 3, 2007, from

http://eric.ed.gov/ERICDocs/data/ericdocs2/content_storage_01/0000000b/80/26/c2/2b.pdf

Newmann, F. M. (Ed.), Wehlage, G. G., & Lamborn, S. D. (1992). The Significance and Sources of Student Engagement. In *Student Engagement and Achievement in American Schools* (chap. 1). Retrieved March 3, 2007, from

http://eric.ed.gov/ERICDocs/data/ericdocs2/content_storage_01/0000000b/80/26/c2/2b.pdf

Nurses May Be Satisfied, but Are They Engaged? (May 14, 2002). Retrieved November 10, 2007, from <http://www.gallup.com/poll/6004/Nurses-May-Satisfied-They-Engaged.aspx>

One-to-One in Ten: A One Student to One Laptop Computer Program Supported to Enrich Teaching and Learning in New York City School Region 10. (2005, August 22). *New York Software Industry Association*. Retrieved December 30, 2005, from http://www.nysia.org/special_features/article.cfm?pid=193

One-to-One Laptops in a High School Environment (Final Report) [Piscataquis Community High School Study]. (2004, February). Retrieved September 17, 2006, from <http://www.notesys.com/Copies/Maine%20finalLaptopreport%20Feb04.pdf>

Parsad, B., & Jones, J. (2005, February). *Internet Access in U.S. Public Schools and Classrooms: 1994–2003 (NCES 2005–015)*. Retrieved December 16, 2007, from <http://nces.ed.gov/pubs2005/2005015.pdf>

Researchers study how technology shapes the ways in which students learn. (November 15, 2006). Retrieved November 10, 2007, from <http://news-service.stanford.edu/news/2006/november15/barron-111506.html?view=print>

ROCKMAN ET AL. (1997, June). *Report of a Laptop Program Pilot*. [A Project for Anytime Anywhere Learning by Microsoft Corporation Notebooks for Schools by Toshiba America Information Systems]. Retrieved October 3, 2006, from http://www.microsoft.com/education/download/aal/resrch_1.rtf

ROCKMAN ET AL. (1998, October). *Powerful Tools for Schooling: Second Year Study of the Laptop Program*. [A Project for Anytime Anywhere Learning by Microsoft Corporation A Project for Anytime Anywhere Learning by Microsoft Corporation Notebooks for Schools by Toshiba America Information Systems]. Retrieved February 23, 2007, from <http://www.microsoft.com/education/download/aal/research2.rtf>

ROCKMAN ET AL. (2000, June). *A More Complex Picture: Laptop Use and Impact in the Context of Changing Home and School Access*. Retrieved February 18, 2007, from <http://download.microsoft.com/download/8/d/c/8dc3ebfe-6849-4534-a4b7-846a8c327874/Research3Report.doc>

ROCKMAN ET AL. (2007, April). *Change & Context: A Five-Year Overview of Two 1:1 Programs*. Retrieved December 16, 2007, from <http://www.rockman.com/publications/presentations/ChangeContextPaper.pdf>

Rockman, S. (October 15, 2004). A Study in Learning. *TechLearning*. Retrieved January 2, 2007, from <http://www.techlearning.com/showArticle.php?articleID=49901145>

Ross, S. M., Lowther, D. L., & Morrison, G. R. (2001, December). *ANYTIME, ANYWHERE LEARNING FINAL EVALUATION REPORT OF THE LAPTOP PROGRAM: YEAR 2*. Retrieved February 19, 2007, from http://www.walledlake.k12.mi.us/aal/Research/Eval_Year_2.pdf

Ross, S. M., Lowther, D. L., Wilson-Relyea, B., Wang, W., & Morrison, G. R. (2003, December). *ANYTIME, ANYWHERE LEARNING FINAL EVALUATION REPORT OF THE LAPTOP PROGRAM: YEAR 3*. Retrieved February 18, 2007, from http://www.walledlake.k12.mi.us/aal/Research/Laptop_Report_Yr3.pdf

Ross, S. M., Morrison, G. R., Lowther, D. L., & Plants, R. T. (September 30, 2000). *ANYTIME, ANYWHERE LEARNING FINAL EVALUATION REPORT OF THE LAPTOP PROGRAM*. Retrieved February 19, 2007, from <http://www.walledlake.k12.mi.us/aal/Research/evaluation1.pdf>

- Russell, M., Bebell, D., & Higgins, J. (2004). *Laptop Learning: A Comparison of Teaching and Learning in Upper Elementary Classrooms Equipped With Shared Carts of Laptops and Permanent 1:1 Laptops*. Retrieved February 22, 2007, from <http://escholarship.bc.edu/cgi/viewcontent.cgi?article=1000&context=intasc>
- Shapley, K. S., Sheehan, D., Sturges, K., Caranikas-Walker, F., Huntsberger, B., & Maolney, C. (2006, June). *Effects of Technology Immersion on Teaching and Learning: Evidence from Observations of Sixth-Grade Classrooms*. Retrieved February 17, 2007, from http://www.etxtip.info/images/06.05.06_eTxTIP_Classroom_Observation_Report.pdf
- Shapley, K., Sheehan, D., Sturges, K., Caranikas-Walker, F., Huntsberger, B., & Maolney, C. (2006, April). *Evaluation of the Texas Technology Immersion Pilot: First-Year Results*. Retrieved February 17, 2007, from http://www.etxtip.info/images/06.05.06_eTxTIP_Year_1_Report.pdf
- Sharp, D. (October 31, 2007). Maine's Laptop Program Found to Aid Student Writing Scores in Writing. *Education Week*, 27(10), 11.
- Silvernail, D. L., & Lane, D. M. M. (2004, February). *The Impact of Maine's One-to-One Laptop Program on Middle School Teachers and Students* (Research Report #1) [Phase One Summary Evidence]. Retrieved February 23, 2007, from <http://www.usm.maine.edu/cepare/pdf/mlti/MLTI%20Phase%20One%20Evaluation%20Report%201.pdf>
- Sloss, E., & Potts, J. (November 20, 2006). *Carnegie Mellon University Press Release*. [Carnegie Mellon Research Shows Laptops in Classrooms Isolate Students]. Retrieved January 2, 2007, from <http://www.cmu.edu/news/archive/2006/november/nov.-20-laptop-study.shtml>
- Stake, R. E. (1995). *The Art of Case Study Research* (p. xi). Thousand Oaks, California: SAGE Publications.

- Stevenson, K. R. (1998, November). *Evaluatin Report - Year2, Schoolbook Laptop Project, Beaufort County School District, Beaufort, South Carolina*. Retrieved February 22, 2007, from <http://www.beaufort.k12.sc.us/district/ltopeval.html>
- Stevenson, K. R. (1999, November). *Evaluatin Report - Year 3, Schoolbook Laptop Project, Beaufort County School District, Beaufort, South Carolina*. Retrieved February 22, 2007, from <http://www.beaufort.k12.sc.us/district/evalreport3.htm>
- Stevenson, K. R. (2004, January). *Evaluatin Report - Year 3, High School Laptop Computer Program, Liverpool Central School District, Liverpool, New York*. Retrieved February 22, 2007, from <http://www.liverpool.k12.ny.us/Laptops/3rdyearevl.pdf>
- Strebinsky, A. (2003, January). *Special Learners Included Through Computers in Education (SLICE) Evaluation Report*. Retrieved February 23, 2007, from http://apelslice.com/downloads/slice_evaluation_report.pdf
- The 'brutal facts' of 1-to-1 computing*. (May 1, 2006). Retrieved November 10, 2007, from eSchool News online:
<http://www.eschoolnews.com/news/PFshowstory.cfm?ArticleID=6284>
- The Greaves Group, The Hayes Connection. (2006). *America's Digital Schools 2006, Key Findings*. Retrieved February 17, 2007, from <http://www.ads2006.org/main/pdf/ADS2006KF.pdf>
- U.S. Bureau of the Census. (1985, December). *Statistical Abstract of the United States: 1986 (106th Edition)*. Retrieved November 10, 2006, from <http://www2.census.gov/prod2/statcomp/documents/1986-03.pdf>
- U.S. Bureau of the Census. (1994, September). *Statistical Abstract of the United States: 1994 (114th Edition)*. Retrieved November 10, 2006, from <http://www2.census.gov/prod2/statcomp/documents/1994-03.pdf>
- U.S. Bureau of the Census. (1997, December). *Section 4: Education*. Retrieved December 10, 2006, from <http://www.census.gov/prod/3/97pubs/97statab/educ.pdf>

- U.S. Bureau of the Census. (n.d.). *Computers for Student Instruction in Elementary and Secondary Schools: 2005-2006* (Table 248). Retrieved July 8, 2007, from <http://www.census.gov/compendia/statab/tables/07s0248.xls>
- U.S. Department of Education. (2000, December). *e-Learning: Putting a World-Class Education at the Fingertips of All Children*. [THE NATIONAL EDUCATIONAL TECHNOLOGY PLAN]. Retrieved January 6, 2007, from <http://www.ed.gov/about/offices/list/os/technology/reports/e-learning.html>
- U.S. Department of Education, Office of Educational Technology. (2004). *Toward A New Golden Age in American Education: How the Internet, the Law and Today's Students Are Revolutionizing Expectations*. Retrieved November 3, 2006, from <http://www.ed.gov/about/offices/list/os/technology/plan/2004/plan.pdf>
- Voices of Students on Engagement: A Report on the 2006 High School Survey of Student Engagement*. (June 1, 2007). Retrieved November 9, 2007, from http://ceep.indiana.edu/hssse/pdf/HSSSE_2006_Report.pdf
- Warschauer, M. (2007). Information Literacy in the Laptop Classroom. *Teachers College Record*, 109(Number 11, 2007), 2511-2540. Retrieved November 9, 2007, from <http://www.tcrecord.org/PrintContent.asp?ContentID=14534>:
- Wenglinsky, H. (1998, September). *Does It Compute? The Relationship Between Educational Technology and Student Achievement in Mathematics*. Retrieved February 19, 2007, from <ftp://ftp.ets.org/pub/res/technolog.pdf>
- What Student Engagement Data Tell Us about College Readiness. (2007). *Association of American Colleges and Universities peer Review*, (Winter 2007). Retrieved November 9, 2007, from http://nsse.iub.edu/uploads/PRWI07_Kuh.pdf
- Zhao, Y., Pugh, K., Sheldon, S., & Byers, J. L. (2002, April). Conditions for Classroom Technology Innovations. *Teachers College Record*, 104(3), 482-515. Retrieved September 18, 2006, from <https://www.tcrecord.org/Content.asp?ContentID=10850>

Zucker, A. A., & McGhee, R. (2005, February). A Study of One-to-One Computer Use in Mathematics and Science Instruction at the Secondary Level in Henrico County Public Schools. Retrieved February 18, 2007, from <http://ubiqcomputing.org/FinalReport.pdf>

Appendix A

Teacher and Administrator Recruiting Script

Teacher and Administrator Recruiting Script

Thank you for taking the time to visit with me. I am a graduate student at the University of Nebraska-Lincoln and working to complete my doctoral dissertation. My dissertation topic relates to the effects of one-to-one computing on teaching and learning in high schools. My research involves interviewing administrators and teachers in schools with one-to-one computing. I'd like to invite you to participate in my study. If you choose to participate in my study, I will administer a 10 question interview. The interview takes about 30 minutes, depending on the length of your answers. I will conduct the interview at your school in a place of your choice. During the interview, I will record notes from your responses. Approximately a week after the interview, I will send you my notes from your interview and invite you to review my notes and make corrections as you see fit. The review should take about 10 minutes to complete. All information gathered during the interview will be considered confidential and only shared in the context of my dissertation and related presentations and/or journal articles. I will provide a copy of my dissertation to each of the schools participating in my study. If you decide to participate, your participation is completely voluntary, and you may withdraw from the study at any time with no adverse affects to you or your school.

I would like to invite you to participate by allowing me to interview you for my dissertation research. Are you willing to be a participant in my study?

Appendix B

Administrator Interview Questions

Administrator Interview Questions

1. What are your goals for the one-to-one computing initiative in your building?
2. How has teaching changed in the building since the introduction of one-to-one computing?
3. Please give me an example of something that you have observed a teacher doing with computers that you thought worked particularly well with students.
4. What are some of the benefits for students in a one-to-one computing environment?
5. In what ways has student learning changed since the introduction of one-to-one computing in the building?
6. How has your job changed since the introduction of a one-to-one computing environment?
7. What concerns do you have regarding one-to-one computing?
8. What are the challenges to continuing and maintaining a one-to-one computing environment in your building?
9. (This question was not used at Riverside HS by request of the Assistant Superintendent.) Which 5 teachers do you think have been the most successful in changing teaching and learning in their classroom since the introduction of one-to-one computing that I might contact for participation in the study?
10. What else would you like to tell me about one-to-one computing?

Appendix C
Teacher Interview Questions

Teacher Interview Questions

1. How have you used your laptop since one-to-one computing has been implemented in your building?
2. Please give me an example of a practical goal you hope to accomplish with the laptops in your classroom?
3. How has your instruction changed since the introduction of one-to-one computing in the building?
4. Please give me an example of something that you have done with the laptops that would be unexpected or different from your normal instructional methods?
5. What are some of the benefits for students in a one-to-one computing environment?
6. How has student learning changed in your classroom since the introduction of one-to-one computing?
7. Describe how your classroom has changed since the implementation of one-to-one computing?
8. Please give me an example of one thing you did with your laptop that you thought worked particularly well with students.
9. What concerns do you have regarding one-to-one computing?
10. What else would you like to tell me about one-to-one computing?

Appendix D
Informed Consent Form

INFORMED CONSENT FORM

Title of Project:

A Case Study of One-to-One Computing: The Effects on Teaching and Learning

Purpose of the Research:

The research is a case study of three Midwestern high schools that have adopted a one-to-one computing environment. The study will focus on changes in teaching and learning that have occurred since the implementation of one-to-one computing in each of the schools. The intent of the research is to provide additional information to school districts and school boards that may be considering the adoption of one-to-one computing. Building administrators and teachers in the identified schools will be invited to participate in the study.

Data gathered in this study will be presented in a doctoral dissertation. In addition, data may potentially be included in published, professional journals and/or presented at professional conferences.

Procedures:

Participation in this study is strictly voluntary and will require approximately 40 minutes of your time. First, a 10 question interview will be administered. The interview will last approximately 30 minutes. The length of your answers may affect the time required for the interview. The interviews will be conducted in each participant's school at a place chosen by the participant. The researcher will take field notes during the interview, but will **NOT** video-tape or record your answers electronically. Within approximately one week following the interview, you will receive a copy of the researcher's field notes and will be asked to review and make corrections as needed. The review of the field notes will take approximately 10 minutes of your time.

Any information obtained during this research project will be handled with the utmost confidentiality. Pseudonyms will be used for all people participating in the project, as well as for the school districts in which the participants are employed. All field notes will be kept in a locked cabinet in the home of the primary investigator. The primary investigator will have exclusive access to the field notes. Information gathered by the researcher will only be shared in the context of the final project. All field notes will be stored for three years past the completion of the study and will then be destroyed.

Risks and/or Discomforts:

There are no known risks or discomforts associated with this research.

Participant's Initials: _____

Benefits:

This study is not designed to benefit you personally, however, you may find that your involvement in this project is an opportunity to examine and reflect on your experiences with one-to-one computing. There will be no financial compensation or academic credit of any kind offered or given to any participant in this project. However, all participants will have access to the findings of the study and the final study in its entirety if they so desire.

Additional Information:

You may ask questions concerning this research project and have those questions answered prior to agreeing to participate in this study. You may contact the primary investigator, **Dick Meyer, at (308) 238-0920 or (308) 293-4746, or Dr. Larry Dlugosh at (402) 472-0975.** You may also e-mail Dick Meyer at dick.meyer@kearneypublic.org if you have questions about the project. If you have additional questions about your rights as a participant in this study which are not answered by the above investigators, or to report any concerns, please contact the **University of Nebraska-Lincoln Institutional Review Board at (402) 472-6965.**

Your participation at every point in this study is voluntary. You have the right to withdraw from the study at any time without adversely affecting your standing with the University of Nebraska-Lincoln or the investigators or your institution. Your decision will not result in any loss of benefits to which you are otherwise entitled.

Your signature indicates and certifies that you have decided to participate in this study after having read and fully comprehending the information presented in this informed consent. You will be given a copy of the consent form to keep with your records.

Name (Printed): _____ Date: _____

Signature: _____

Dick Meyer
Office: (308) 698-8054
Cell: (308) 293-4746
Home: (308) 238-0920
Email: dick.meyer@kearneypublic.org

Larry L. Dlugosh, Ph.D.
Office: (402) 472-0975
Email: ldlugosh1@unl.edu

Appendix E

Institutional Review Board Approval Letter

November 14, 2007

Richard Meyer
Dr. Larry Dlugosh
4316 29th Ave
Kearney NE 68845

IRB# 2007-11-8223 EX

TITLE OF PROJECT: **A Case Study of One-to-One Computing: The Effects on Teaching and Learning**

Dear Richard:

This letter is to officially notify you of the approval of your project by the Institutional Review Board (IRB) for the Protection of Human Subjects. This project has been approved by the Unit Review Committee from your college and sent to the IRB. It is the Board's opinion that you have provided adequate safeguards for the rights and welfare of the participants in this study. Your proposal seems to be in compliance with this institution's Federal Wide Assurance 00002258 and the DHHS Regulations for the Protection of Human Subjects (45 CFR 46) and has been classified as exempt.

Date of EX Review: 11/05/07

You are authorized to implement this study as of the Date of Final Approval: 11/14/07. This approval is Valid Until: 11/13/08.

1. Attached on NUgrant is the IRB approved informed consent forms for this project. Please use these forms when making copies to distribute to your participants. If it is necessary to create a new informed consent form, please send us your original so that we may approve and stamp it before it is distributed to participants.

We wish to remind you that the principal investigator is responsible for reporting to this Board any of the following events within 48 hours of the event:

- Any serious event (including on-site and off-site adverse events, injuries, side effects, deaths, or other problems) which in the opinion of the local investigator was unanticipated, involved risk to subjects or others, and was possibly related to the research procedures;
- Any serious accidental or unintentional change to the IRB-approved protocol that involves risk or has the potential to recur;
- Any publication in the literature, safety monitoring report, interim result or other finding that indicates an unexpected change to the risk/benefit ratio of the research;
- Any breach in confidentiality or compromise in data privacy related to the subject or others; or
- Any complaint of a subject that indicates an unanticipated risk or that cannot be resolved by the research staff.

This project should be conducted in full accordance with all applicable sections of the IRB Guidelines and you should notify the IRB immediately of any proposed changes that may affect the exempt status of your research project. You should report any unanticipated problems involving risks to the participants or others to the Board. For projects which continue beyond one year from the starting date, the IRB will request continuing review and update of the research project. Your study will be due for continuing review as indicated above. The investigator must also advise the Board when this study is finished or discontinued by completing the enclosed Protocol Final Report form and returning it to the Institutional Review Board.

If you have any questions, please contact Shirley Horstman, IRB Administrator, at 472-9417 or email at shorstman1@unl.edu.

Sincerely,


Dan R. Hoyt, Chair
for the IRB