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The Effect of a Yearlong One-To-One Laptop Computer Classroom Program on the 4th-Grade Achievement and Technology Outcomes of Digital Divide Learners

Daniel H. Bird

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The Effect of a Yearlong One-To-One Laptop Computer
Classroom Program on the 4th-Grade Achievement and
Technology Outcomes of Digital Divide Learners

By

Daniel H. Bird

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 Education
In Educational Administration

Omaha, Nebraska

2008

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ABSTRACT

THE EFFECT OF A YEARLONG ONE-TO-ONE LAPTOP COMPUTER
CLASSROOM PROGRAM ON THE 4TH-GRADE ACHIEVEMENT AND
TECHNOLOGY OUTCOMES OF DIGITAL DIVIDE LEARNERS

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Advisor: Dr. John W. Hill

A yearlong one-to-one computer laptop classroom instruction intervention program used to prepare 4th-grade students for participation in computer learning activities was evaluated. Students used computers to complete daily reading, writing, and Internet search assignments. Students were divided into two groups according to past computer access; Digital Divide Learners ($n = 10$) who did not have computers and Internet access at home, and Digital Native Learners ($n = 15$) who did have computers and Internet access at home. Reading, writing, total technology skills domain scores, and keyboarding speed and accuracy outcomes were evaluated. Results indicate reading vocabulary, reading comprehension, and writing pretest-posttest test score gain for both groups. However, the null hypothesis was rejected only for the Digital Native Learners reading vocabulary pretest-posttest comparison. The null hypothesis was not rejected for any of the reading and writing

posttest-posttest comparisons. The null hypothesis was rejected for all pretest-posttest computer learning scores for both groups. Only the keyboarding accuracy posttest-posttest comparison was found to be statistically significantly different in the direction of greater accuracy scores for the Digital Native Learners. Computer competence for all students must begin in our classrooms.

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Moving up the educational ladder is stimulating and challenging, but ultimately very rewarding. Accolades are offered the individual at each level of accomplishment, but it is truly a team effort and I would like to recognize and thank each of the following for their help, understanding, and encouragement.

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CHAPTER ONE

Introduction

It is critical today that all students in all schools regardless of their family's economic status (Judge, Puckett, & Bell, 2006) use computers for virtually every lesson not only in their classrooms but also in their homes (Wambach, 2006). Computers support and foster children's new learning (Borzekowski & Robinson, 2005; Lowther, Ross, & Morrison, 2003; NTIA, 2004), new interests (New Media Consortium, 2007), and new ways to organize and access information (Hargis & Schofield, 2006; Robinson, DiMaggio, & Hargittai, 2003; Silvernail & Lane, 2004) as they actively improve their own achievement (Dunleavy, Dexter, & Heinecke, 2007).

While most children do have some access to computers at school (Parsad & Jones, 2005) their computing time is often limited to drill and practice lessons (Becker, 2000; Van Eck, 2006). For students who have computers at home and use them every day to complete assignments and engage in new learning and Internet based discovery, not having individual daily access to a computer at school may not pose a problem for their achievement (Judge et al., 2006). However, students from families without sufficient discretionary income necessary to afford, purchase, and

connect home computers have limited opportunities to engage in robust assignment completion and exploratory wonderment (Seiter, 2004).

If Thomas Friedman (2005) is correct, and we are becoming a *flat-world society*, with a global culture of education in which technology takes a center role, then it follows that those students who are not active participants in that technology will be denied opportunities. The importance of reducing information poverty and the increasing inequalities between the information "haves" and "have-nots" has come to the attention of international agencies such as the World Bank, the International Telecommunications Union (ITU), and the United Nations Development Programme (Norris, 2001). Economic leaders believe the divide has major effects upon the world, and are asking for government, non-profit, and corporate initiatives to find solutions to bridge the global digital divide (Norris, 2001).

The term *digital divide* has been coined to differentiate between the technology "haves" and "have-nots" (Wilhelm, Carmen, & Reynolds, 2002), but a broader concern is at play here. Families who already are struggling from a lower socioeconomic status may have an even more difficult time in the future because they are

being excluded from the technology revolution that is sweeping social and economic conditions in our world (Attewell, Suazo-Garcia, & Battle, 2003). The divide denies access to technology that is thought to be open to everyone, much like public libraries (Robinson et al., 2003). Another problem arises. Even if universal access was available for all families regardless of income, and the so-called digital divide would disappear, "societal reinforcement" and use of the computer and Internet might not be the same for all levels of income (Morgan & VanLengen, 2003). Simply possessing the tools will not necessarily even the technological playing field; a great deal of education for teachers, students, and parents would still be needed. Data from a national sample provides a positive note: though poor youth were only .36 times as likely to have computer access at home, they were just as likely to use home computers for academic purposes as their higher income counterparts (Eamon, 2004). However, students without home computer resources are less likely to attend schools that provide student Internet access (DeBell & Chapman, 2006). This effectively doubles the challenges for those students and schools, and lower poverty schools had significantly more access to home computers than higher poverty schools (Judge et al., 2006).

To fully participate in the 21st century, students must have access to the rich content available online. The hardware, knowledge, and skills required for searching, viewing, understanding, and downloading information are vital. All aspects of students future lives will be affected by computer-based information including their health care, cultural and political news, social communication, employment opportunities, educational materials, and government resources--available only to those who have computing tools and the ability to use them (Campbell, 2001; CEO Forum, 2001; DiMaggio & Hargittai, 2001).

Wilhelm et al. (2002) summed it up this way:

Technology has so transformed the American workplace that young people entering the labor force without significant experience using computers and the Internet will be at a severe disadvantage, and employers who lack technologically trained workers will be handicapped as they compete in an increasingly global economy. (p. 8)

All students, especially those who are in the lowest income households, must participate in the rapidly changing digital world and in so doing avoid becoming another generation trapped in poverty. How? In order to survive,

with the vast amount of information to be managed, and the influence technology has on every aspect of 21st century life, students need to acquire new, evolving skill sets. Technology can help bridge the gap between success and failure, hope and despair, and important work and unemployment for today's students who will be tomorrow's leaders.

Computer Use at School

Using computers for certain lessons. Having access to computers in schools is simply not enough. The way in which students interact with computers and technology is the key. If computers are used, as they often are in high poverty schools, for drill and practice, then improved learning outcomes are not likely to occur (Becker, 2000). Overall, in these schools of poverty, 51% of computer-based activities assigned by teachers were found to be drills, rather than high level thinking activities (CEO Forum, 2001). The acquisition of machines is only the start.

School policy and limited computer availability. In 1998, at the elementary level in the United States, there was one computer available for every 13.6 students. However, by 2003 the ratio had been cut to one computer for every 4.9 students (Parsad & Jones, 2005). While there has been improvement over time this level of computer access

may not be good enough for disadvantaged students because their more advantaged peers almost without exception have access to their own computers at home, every day, and in many schools even have assigned laptop computers, and a staggering 93% of teachers surveyed believed that having a computer with Internet access at home gives a student an education advantage (Kaiser Family Foundation, 2004).

Teacher computing skills. Even when computers are available, teachers must have the expertise to successfully teach, integrate, and trouble-shoot as students freely use technology in the classroom. All classrooms at all levels must have highly qualified teachers, and today highly qualified includes teachers' pedagogical beliefs, confidence in using technology, and an understanding of the benefits of technology for all students (Ertmer, 2005; Wilhelm et al., 2002). However, there are factors that teachers cannot control including their school district's emphasis (or non-emphasis) on technology, school and district leaders' understanding and modeling of the uses of 21st century skills in the classroom, availability and timely replacement of hardware and software for teachers and students, and policies in place supporting student use of technology (O'Dwyer, Russell, & BeBell, 2004). It is important that teachers understand that they do not have to

be the only experts in the classrooms as students themselves are often the best technology resources (Maddux & Johnson, 2005). This teaching paradigm shift may be difficult for some teachers.

Technology that supports content, learner excitement, and engagement, must be the primary focus of teachers' professional development—professional development that has traditionally been focused on the tried and true paper and pencil curriculum already in place. Technology requires teachers to step outside of their comfort zones (Staples, Pugach, & Hines, 2005).

Computer Use at Home

Home computer purchases and use. Much like radio, color television, cable, and cellular phones, households with higher incomes began purchasing and using computers and Internet services earlier than households with lesser means. Though there is growth in the number of computer purchases by families across the entire economic spectrum these purchases are slower for poorer households creating a digital disadvantage for children born into these homes (Martin, 2003). Access to computers at home is not enough for young students. The learning potential inherent in using computers and the Internet must be harnessed. With guidance to the quality digital learning tools available,

good educational Internet sites, and with adult mediation and support, technology use in the home can lead to significant achievement for young children (Espinosa, Laffey, Whittaker, & Sheng 2006).

Computer and Internet access. The number of computers in the home, the use of the Internet, and the range of computer activities increases yearly. Computer activities include the powerful ability to access virtually any information from anywhere on the globe. Information and content are available as text, pictures, audio and video files, and are often free for downloading. Communication is greatly enhanced with video and audio connections with people anywhere, including governments, businesses, and organizations. This is all in *real time*, without wires (NTIA, 2004). However, access to these 21st century forms of technology is far from universal. Almost all adolescents living in the highest income families use computers at home (97%), while about a third (33%) of those in the lowest income families use computers at home (NTIA, 2002). The technological divide is wide and the long-term effects upon lower income families go far beyond simply not having the hardware and skills, but also result in a lag in other forms of social and economic equality (Martin, 2003).

Parent computer skills. When computers are an

important part of parents' work, there is a higher likelihood of computer access and use at home. Conversely, lower paying jobs, often the fate of the poor and lesser educated, may call for rudimentary computer skills, or none at all, and valuable exposure to technology in the work place may not occur. This widens the digital divide for those parents and families of lesser means (Morgan & VanLengen, 2002). In a field survey study, high school dropouts were found to have used the Internet for information needed for their work 42% in a twelve-month period, while those with some graduate school education used the Internet for the same purpose 84% in that time frame (Robinson et al., 2003). That study also found that those who used the Internet less were not as likely to visit web sites to seek information about political issues and current affairs, 18% versus 50%.

Preparing students for the future must take center stage. The U.S. Bureau of Labor Statistics show that eight of the ten fastest growing occupations are computer-related (U.S Bureau of Statistics, 2000) and young workers prepared with "21st century literacy" skills will see enormous opportunities and possibilities. The number one fastest growing occupation at this time is in network systems and data communications and related analysts positions (U.S.

Bureau of Statistics, 2007).

Parents' education is also an important factor. Computers were found in 35% of households in which parents had not completed high school, while 55% of households had computers when parents were high school graduates. The numbers continue to rise with the educational level of parents: 72% had computers that attended some college; 82% when parent(s) had completed a bachelor's degree; and those households in which the parent(s) had graduate degrees topped out at 88% (DeBell & Chapman, 2006). Digital divide learners often struggle with both--poverty and low educational family history.

Student Achievement

The overall effect of computer use in the elementary years on achievement has been positive, with some important findings. Males enjoyed improved attitudes towards school while females on the other hand felt strongly that computer use improved their study habits and creativity. Using computers resulted in improved achievement scores in math and reading for both boys and girls (Hargis & Schofield, 2006). Though most of the results are positive, there are some concerns, including: possible distraction in the classroom, inappropriate laptop use by some students, and

technology failure that interrupts class activities (Becker, 2000; Mitchell Institute, 2004).

Student Discovery

Using the Internet for important incidental learning.

Students who browse the vast storehouse of the Internet often come upon information and topics that might be deemed just-in-time, accidental, or incidental learning. This learning is often outside any curricular focus, is personal, of high interest, and usually in smaller chunks of knowledge, making it easier to assimilate. This kind of student discovery is potent, and is often more in line with a students' own pursuit of knowledge (Hoffman, 2005). Lacking a computer at home this opportunity is missed.

Purpose of the Study

The purpose of this study was to determine the effect of a yearlong one-to-one laptop computer classroom program on the achievement and technology outcomes of 4th-grade digital divide learners from homes without computer access compared to achievement and technology outcomes of 4th-grade digital native learners from homes with computer access who also participated in the yearlong one-to-one laptop computer classroom program.

Importance of the Study

This study is of particular interest and importance to elementary schools considering one-to-one laptop initiatives, and the effect of such programs upon the achievement of students of poverty. Providing a laptop during the school day and utilizing it in all curricular areas deserves a close look, and the findings could lead to changes in how best to close the digital divide.

Research Questions

The following research questions were used to analyze the 4th-grade achievement outcomes of Digital Divide Learners (DDL) and Digital Native Learners (DNL) following participation in a yearlong one-to-one laptop computer classroom program.

Overarching Pretest-Posttest Achievement Research Question #1: Do DDLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade District Writing Assessment scores following participation in a one-to-one laptop computer classroom program?

Sub-Question 1a. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade District Writing Assessment scores following participation in a one-to-one laptop computer classroom program?

Overarching Pretest-Posttest Achievement Research

Question #2: Do DNLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade District Writing Assessment scores following participation in a one-to-one laptop computer classroom program?

Sub-Question 2a. Is there a statistically significant difference between DNLs' beginning 4th-grade compared to ending 4th-grade District Writing Assessment scores following participation in a one-to-one laptop computer classroom program?

Overarching Posttest-Posttest Achievement Research

Question #3: Do DDLs have congruent or different ending 4th-grade District Writing Assessment scores compared to DNLs ending 4th-grade District Writing Assessment scores?

Sub-Question 3a. Is there a statistically significant difference between DDLs' ending 4th-grade District Writing Assessment compared to DNLs' ending 4th-grade District Writing Assessment scores following participation in a one-to-one laptop computer classroom program?

Overarching Pretest-Posttest Achievement Research

Question #4: Do DDLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade norm-referenced California Achievement Test CAT/5 NCE scores for

(a) vocabulary, and (b) reading comprehension, following participation in a one-to-one laptop computer classroom program?

Sub-Question 4a. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade Test CAT/5 NCE scores for (a) vocabulary following participation in a one-to-one laptop computer classroom program?

Sub-Question 4b. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade Test CAT/5 NCE scores for (b) reading comprehension following participation in a one-to-one laptop computer classroom program?

Overarching Pretest-Posttest Achievement Research
Question #5: DNLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade norm-referenced California Achievement Test CAT/5 NCE scores for (a) vocabulary, and (b) reading comprehension following participation in a one-to-one laptop computer classroom program?

Sub-Question 5a. Is there a statistically significant difference between DNLs' beginning 4th-grade compared to ending 4th-grade Test CAT/5 NCE scores for (a)

vocabulary following participation in a one-to-one laptop computer classroom program?

Sub-Question 5b. Is there a statistically significant difference between DNLs' beginning 4th-grade compared to ending 4th-grade CAT/5 NCE scores for (b) reading comprehension following participation in a one-to-one laptop computer classroom program?

Overarching Posttest-Posttest Achievement Research
Question #6: Do DDLs' have congruent or different ending 4th-grade norm-referenced California Achievement Test (CAT/5) NCE scores for (a) vocabulary, and (b) reading comprehension compared to DNLs' ending 4th-grade norm-referenced California Achievement Test (CAT/5) NCE scores for (a) vocabulary, and (b) reading comprehension following participation in a one-to-one laptop computer classroom program?

Sub-Question 6a. Is there a statistically significant difference between DDLs' ending 4th-grade CAT/5 NCE scores for (a) vocabulary compared to DNLs' ending 4th-grade CAT/5 NCE scores for (a) vocabulary following participation in a one-to-one laptop computer classroom program?

Sub-Question 6b. Is there a statistically significant difference between DDLs' ending 4th-grade CAT/5

NCE scores for (b) reading comprehension compared to DNLs' ending 4th-grade CAT/5 NCE scores for (b) reading comprehension following participation in a one-to-one laptop computer classroom program?

The following research questions will be used to analyze the 4th-grade technology outcomes of Digital Divide Learners (DDL) and Digital Native Learners (DNL) following participation in a yearlong one-to-one laptop computer classroom program.

Overarching Pretest-Posttest Achievement Research Question #7: Do DDLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom?

Research Sub-Question 7a. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom?

Overarching Pretest-Posttest Achievement Research Question #8: Do DNLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom?

Research Sub-Question 8a. Is there a statistically significant difference between DNLs' beginning 4th-grade compared to ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom?

Overarching Posttest-Posttest Achievement Research Question #9: Do DDLs have congruent or different ending 4th-grade teacher-evaluated student technology skills rubric scores compared to DNLs' ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom program?

Research Sub-Question 9a. Is there a statistically significant difference between DDLs' ending 4th-grade teacher-evaluated student technology skills rubric scores compared to DNLs' ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom program?

Overarching Pretest-Posttest Achievement Research Question #10: Do DDLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade keyboarding scores for (a) speed, and (b) accuracy

following participation in a one-to-one laptop computer classroom program?

Sub-Question 10a. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade keyboarding scores for (a) speed following participation in a one-to-one laptop computer classroom?

Sub-Question 10b. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade keyboarding scores for (b) accuracy following participation in a one-to-one laptop computer classroom?

Overarching Pretest-Posttest Achievement Research Question #11: Do DDLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade keyboarding scores for (a) speed, and (b) accuracy following participation in a one-to-one laptop computer classroom program?

Sub-Question 11a. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade keyboarding scores for (a) speed following participation in a one-to-one laptop computer classroom program?

Sub-Question 11b. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade keyboarding scores for (b) accuracy following participation in a one-to-one laptop computer classroom program?

Overarching Posttest-Posttest Achievement Research Question #12: Do DDLs have congruent or different ending 4th-grade keyboarding scores compared to DNLs' ending 4th-grade keyboarding scores for (a) speed and (b) accuracy following participation in a one-to-one laptop computer classroom program?

Research Sub-Question 12a. Is there a statistically significant difference between DDLs' ending 4th-grade keyboarding scores compared to DNLs' ending 4th-grade keyboarding scores for (a) speed following participation in a one-to-one laptop computer classroom program?

Research Sub-Question 12b. Is there a statistically significant difference between DDLs' ending 4th-grade keyboarding scores compared to DNLs' ending 4th-grade keyboarding scores for (b) accuracy following participation in a one-to-one laptop computer classroom program?

Assumptions

The study design has several strong features including: (a) all students participating in the study were housed in the same elementary school building; (b) all students had equal access to laptops during the school day; and (c) all students were taught and assessed using the same district-approved curriculum and assessments.

Delimitations

This study was delimited to 4th-grade students from two classrooms in one urban elementary school. The research results were delimited to those students who attended school during the entire 2007-2008 school year, and took part in the one-to-one laptop pilot program.

Limitations

This exploratory study was confined to two classrooms of 4th-grade students enrolled in the same school during one school year. The students who participated ($N = 25$) were from two naturally formed groups of digital divide learners ($n = 10$) and digital native learners ($n = 15$). The small number of study participants may skew the statistical results and limit the potential to generalize the research findings.

Definitions of Terms

21st century skills. The skills students need to succeed in work, school, and life. They include but are not limited to the following: *21st century content:* global awareness; financial, economic, business, and entrepreneurial literacy; civic literacy and health and wellness awareness. *Learning and thinking skills:* critical thinking and problem solving skills, communications skills, creativity and innovation skills, collaboration skills, contextual learning skills, and information and media literacy skills.

Accidental and incidental learning. In this study, accidental or incidental learning refers to a "by-product" of research that builds the knowledge base, but may not be directly related to the topic; knowledge outside the area of study that occurs. This learning is often of high interest to the student.

Achievement. In this study, achievement refers to improvement in academic endeavors. The goal is to raise understanding and learning through rigorous lessons, and through assessments gauge achievement.

At-risk students. Students at-risk have a greater likelihood of becoming educationally disabled because of

conditions surrounding their births or home environments (Texas Education Agency, 1999).

California Achievement Tests (CATs). Standardized norm-referenced tests used to ascertain student mastery of basic skills and to compare student achievement in the Omaha Public Schools with student achievement in this state and in the nation. Reading scores only will be utilized in this study.

Computer applications. In this study, computer applications refer to software used within the classroom. Examples would include Microsoft Word, Inspiration, and FirstClass e-mail.

Criterion referenced tests (CRTs). Criterion-referenced standardized tests will be used to determine student mastery of higher-level skills and applications described in the district and state's curriculum standards.

Digital assignments. In this study, a digital assignment refers to classroom work and/or projects that are expected to be completed using computers, not pencil, pen, paper, or other tools.

Digital divide learners (DDLs). In this study, digital divide learners refer to students who have not had access to computers and the Internet at home since first grade.

Digital native learners (DNLs). In this study, digital native learners refer to students who have had access to computers and the Internet at home since the 1st-grade.

E-Mail. E-mail refers to electronic mail, a communication form that is based on Internet connectivity, and results in timely, almost instantaneous, written communication to occur.

Facebook. A social networking web site.

<http://www.facebook.com>

Flickr. A photo sharing web site allowing anyone to post and share their own photos on the Internet, and to download photos from other participants.

<http://www.flickr.com>

Google Videos. Google Video hosting web site.

<http://video.google.com/>

Information and communications technology literacy.

Life skills: leadership, ethics, accountability, adaptability, personal productivity, personal responsibility, people skills, self-direction, and social responsibility (National Education Association, 2008).

Internet. The Internet is a worldwide system of computer networks, in which anyone with an Internet connection can search, retrieve, and share information.

Keyboarding skills. For this study, keyboarding skills refers to speed and accuracy of keyboarding or typing ability. The students take a three-minute test at: www.typingtest.com. The test is electronically graded at the end of the allotted time.

Laptop computer. A laptop computer, sometimes referred to as simply a laptop, or notebook computer, is a smaller version of the common desktop computer found in offices and schools. Usually weighing from three to fifteen pounds, power is provided by a single rechargeable battery. Laptops are commonly configured to work wirelessly with the Internet.

My Space. A social networking web site.
<http://www.myspace.com/>

Norm referenced tests (NRT). Norm-referenced tests measure student performance compared to the performance of similar groups of students who have also taken the tests. The California Achievement Tests are an example of an NRT.

One-to-one laptop program. In this study, the one-to-one laptop program refers to providing one laptop computer for each student in the pilot group throughout the school day.

Pilot program. In this study, a pilot program refers to a temporary project involving limited numbers of

schools, classrooms, teachers, and students to test an educational theory or assumption.

Reading comprehension. Reading comprehension refers to techniques for improving students' success in extracting useful knowledge from text (Mayer, 2003), or understanding a text that is read, or the process of "constructing meaning" from a text (National Institute for Literacy, 2005).

Reading fluency. Reading fluency is the ability to read accurately, quickly, effortlessly, and with appropriate expression and meaning (Rasinkski, 2003).

Rubric. A rubric is a set of criteria for grading assignments, often in a table format, which allows for an overall number score.

Skype. Free software that allows video and audio chats via the Internet to anyone in the world.

<http://www.skype.com>

Technology. Technology in this study refers to computers, software applications, peripheral hardware, and the Internet.

The Mixxer. Online community that matches up individuals and groups to practice foreign language skills using Skype, the free, real time video chat site.

<http://www.language-exchanges.org/noLogin.htm>

Web 2.0. Thought of as the 2nd wave of the Internet, which is controlled by the user. Content is created, edited, posted, and shared by anyone. Web 2.0 would include Skype, YouTube, and the like.

Writing assessments. Writing assessments are methods to evaluate accurately students' writing knowledge and skills. These methods will include selected responses and performance-based measures such as observations, performances, products, portfolios, and personal communication. In this study, the Omaha Public Schools' District Writing Assessment scores will be utilized.

YouTube. Web site that hosts video content from anyone on any topic. <http://www.youtube.com>

Significance of the Study

This study contributes to the body of research on the effect of technology in the classroom, specifically; elementary classrooms involved in one-to-one laptop programs. The research results are of significant interest to educators considering ubiquitous laptop programs and the effect on students of poverty who do not have computers and the Internet at home.

Contribution to Research

There is little research available examining the digital divide in the earliest years of schooling. The

results of this study help shed some light on the divide and provide insight into the value of early computer use in the classroom and the effect on achievement and developing 21st century skills.

Contribution to Practice

This study may offer suggestions for bridging the poverty-induced digital divide that exists between elementary students. Examining a one-to-one laptop computer program and specific pretest and posttest scores may suggest effective new pedagogical practices. The goal for all students is to achieve, and using the tools of the 21st century is vital to achieve at the highest level.

Contribution to Policy

At its most basic level the resource rich world of computers and the Internet must be made equally available to all and that starts with disadvantaged students who through no fault of their own, live in a cycle of poverty. This study will examine the effect of laptop access for some of these students. There is a tremendous potential to influence policy decisions on the utilization of such programs in the future.

Organization of the Study

The literature review relevant to this exploratory research study is presented in Chapter 2. This chapter

reviews the professional literature related to the emerging one-to-one laptop programs, how learning in elementary schools is affected by the use of technology, and the relationship between poverty, technology, and achievement. Chapter 3 describes the research design, methodology, independent and dependent variables and procedures that were used to gather and analyze the data of this study. This includes a detailed synthesis to determine if the null was accepted or rejected for each research question.

CHAPTER TWO

Review of Literature

Computer Access

Computers are here to stay in our homes and our schools. As early as 2002, 97% of the highest income adolescents had and used home computers, compared to 33% of the lowest income adolescents (NTIA, 2002). Similar results were found in a more recent report (DeBell & Chapman, 2006) in which 88% of families with income above \$75,000 had home computers, while 37% of families with income below \$20,000 had home computers. The numbers are clear, and not just in homes, but in advantaged neighborhood schools computers are available to students of all ages (Judge et al. 2006), computers are used throughout the school day (Wambach, 2006), computers are used for completing course assignments in all required curriculum areas (Gulek & Demirtas, 2005), and computers are used to create and invent (Turkle, 2004).

Rapidly changing technology. Computer use in the home began in the mid-1980s with the introduction of the Micro Instrumentation and Telemetry Systems Altair 8080 kit. However, the computer kit was not very useful for students. As times changed and computers improved the prices went down and designs were altered to fit students' needs within the educational environment, as well as at home (Veit,

2008).

The cost of home computers was still high, and those who had the means purchased, while those who did not missed out on the early adoptions. Attempts to bridge the technology divide surged forward following the introduction of the one-to-one computing initiative (Kaiser Family Foundation, 2004). The one-to-one computing initiative allowed students for the first time to have access to a laptop computer at school and some students also for the first time had the privilege to take their school computer home. Around the clock access was thought even then to provide an added positive impact for students from families who then could not afford such a luxury. Bringing computers home also resulted in increased family interest and involvement in their student's assignments and homework and higher achievement (McCarrick et al., 2007).

In the last ten years there have been major changes in the availability of technology in schools. Stunningly, in 1994 only 35% of our nation's schools had Internet access, however, by 2007 100%--literally all--of our nations schools were connected to the Internet (U.S. Department of Education, NCES, 2007). These numbers are impressive for schools, however, homes remain much slower to purchase Internet services so many students from homes with economic

need must rely on schools for their technology connections (Eamon, 2004).

Computer use at all grade levels. Sir Francis Bacon (1597) once proclaimed that knowledge is power. If that is so, a vast warehouse of powerful knowledge is available at the end of a few mouse clicks for some children, but unfortunately unavailable for many others. New skill sets will be needed through the school years and beyond just to complete basic assignments and learning projects. The ability to keyboard text or numerical information is one vital example, and if keyboarding skills are weak, creative and eloquent writing is hampered (Warschauer & Grimes, 2005). Schools have clearly helped bridge this divide by making technology an important part of the educational classroom (Stevenson, 1998).

Computer use throughout the school day. Computers and the Internet have changed students' lives in virtually all areas of education and learning. The school district of Vail, Arizona was the first district in the United States to replace textbooks with laptop computers. Vail's Superintendent Calvin Baker has insisted on educational experiences for students that mimic the real world use of technology (eSchool News, 2006). Daily personal access to computers in school is considered the most important factor

in creating equal learning opportunities--made all the more powerful by 24 hour access and one-to-one laptop take home programs (Wambach, 2006). As early as 1990 it was determined that students learned more, learned faster, and had a more positive attitude towards instruction in courses that were computer-based. Findings of these early studies indicated that computer-based instruction resulted in improved student achievement test scores (Kulik, 1994) and using a computer at home increased the likelihood of staying in school and graduating from high school (Fairlie, 2003). Fairlie (2003) found that 95% of children who have computers at home are enrolled in school, while only 85% of children who do not have computers at home are enrolled in school.

Computer use in required curriculum areas. In a three-year study of Maine's laptop initiative, students report that they write more, personalize their learning, and explore more topics on their own leading to the introduction of new ideas (Mitchell Institute, 2004). Frequent use of computers in writing and editing papers resulted in improved Total English, language arts, and writing test scores (O'Dwyer et al., 2005). The conclusion reached in a Vermont K-12 study also documented improved student motivation when computers and technology were

central to assignments. The study suggested that connecting assignments requiring student higher order metacognition to computer and Internet use improved achievement (Russell, Bebell, Higgins, 2004; Sherry, Billig, Jesse, & Watson-Acosta, 2001).

An example of utilizing computer technology might include immersion online in a foreign language environment. This might require the student to participate in an online community like *The Mixxer* (<http://www.language-exchanges.org/noLogin.htm>) that matches up individuals and groups to practice language skills using a web application such as Skype, the free video chat site (<http://www.skype.com>) in which connections are made via the Internet. Distance is no longer a factor in learning today as instant visual and audio communication takes place--in real time--between locations anywhere on the planet.

Technology and writing. The use of word processing in a one-to-one computing environment leads to higher technology literacy and better writing skills (Penuel, 2006). Writing with computers combines keyboarding (typing) skills and a synergistic merger of ideas and structure to create content (Moeller, 2002). However, even when students are more motivated to write using a computer, the level of their

keyboarding skills impacts their sustained interest (Van Leeuwen & Gabriel, 2007). With sufficient keyboarding skills students tended to write longer, more detailed drafts than those who wrote with pen or pencil (Schwartz, 2004). In their meta-analysis of computer use and its effect on student writing, Goldberg, Russell, and Cook (2003) found that when students learned writing skills using computers they were more engaged, motivated, and positive about the length and quality of their draft and final written products. Students with laptop computers show definite writing skills improvement (Lowther, Ross, & Morrison, 2003), and in a study of 1,150 6th-grade and 7th-grade students, an overall 10% gain in writing achievement scores occurred in one year. Jeroski (2005) recently found that when using computers to write, boys' writing scores improved to within 1% of girls' historically greater early writing scores. In the same study 84% of teachers reported they liked having laptops in the classroom and over half believed that the laptops contributed extensively or a great deal to improvement in student writing achievement. Yackanicz (2000) found that reluctant writers were more motivated and wrote more often, over longer periods of time, and produced more writing when using computers rather than pencil and paper. In another study learning disabled

students enjoyed using the computer for word processing, and found that their work looked neat, making the sharing of their ideas easier (Grandgenett, Lloyd, & Hill, 1991).

Computers in the home. Information required for completing school assignments requires the use of outside sources now readily available on the Internet. The ability to locate and synthesize information is a powerful cognitive learning strategy presupposing that the student has the necessary skills to use technology (Alevan & Koedinger, 2002).

Cooperative/collaborative learning. Will Richardson (2006) owner of Connective Learning, LLC, writes:

In an environment where it's easy to publish to the globe, it feels more and more hollow to ask students to "hand in" their homework to an audience of one. When we're faced with a flattening world where collaboration is becoming the norm, forcing students to work alone seems to miss the point. And when many of our students are already building networks far beyond our classroom walls, forming communities around their passions and their talents, it's not hard to understand why rows of desks and time-constrained schedules and standardized tests are feeling more and more limiting and ineffective. (p. 1)

Completing homework. In a poll, 90% of parents believed that access to a home computer assisted children with their homework, and 74% believed that children without access were at an educational disadvantage (Turow & Nir, 2000). In another study, 47% of students used home computers mainly to do homework, while 56% played games (DeBell & Chapman, 2006). Sixty-four percent of students in grades one through five use computers at home, while 84% use them at school (DeBell & Chapman, 2006). Further breakdown of these numbers reveals that lower income affected the numbers a great deal. 25% of K-12 students use home computers to complete assignments when family annual income is below \$20,000, while it jumps to 63% when income is \$75,000 or higher. Word processing use at home by students went from 15% to 47% when comparing the same income groups.

Incidental learning. Computers at home are used for homework it is true, but students are finding other uses as well, and those uses are becoming more of the focus for many students. For example, Eamon (2004) found that only 20% of youth reported using the computer at home *mostly* for academic purposes, while 80% used it for other pursuits, and this was true for poor and non-poor alike.

Social learning. Students today are no longer content to

be consumers of information. They create content, and with Web 2.0 technologies available, they share that content with the world (New Media Consortium, 2007). *Facebook, My Space, Flickr, YouTube, Google Video*, and others, allow for easy posting of photos, personal information, videos, podcasts, blogs, and wikis for anyone to see. Self-created content, once posted, has a worldwide audience, and allows for comparison to other's works, as well as opening the door to collaboration. These tasks were difficult in the past, but only take a few clicks of the mouse to post on shared servers, and most of these tools are free or at very low cost, and since they need nothing more than a web browser, they are very easy to manipulate and edit online (New Media Consortium, 2007).

Visual and auditory factors in computer use.

Interestingly enough, Calvert, Strong, and Gallagher (2005) found that students demonstrated better attention when they were able to control the visual and verbal content. In fact, the *control* factor was found to be a key component in a young student's focus, and computers allowed for that kind of individual control.

Laptops and Achievement

An added value of working directly with computers is the ability teachers have to create individualized instruction,

suites for the abilities and experiences of their students (Dunleavy et al., 2007). Over 70% of teachers surveyed in a report on Maine's laptop initiative for middle schools found that the laptops helped them customize their curriculum to meet individual student's needs, and more than 80% reported that students were more engaged and involved in their learning and produce higher quality work (Silvernail & Lane, 2004). In the same study over 70% of students reported that the laptops helped with organization skills and allowed them to more efficiently complete assignments and improve the quality of their work. Ninth-grade students, who no longer have the use of laptops, claim their work volume and quality has declined. Sustaining a high level of academic achievement was more difficult for middle school students who did not have daily use of laptops, compared to those students who did. This was especially true for at-risk students (Stevenson, 1998).

On state-mandated language arts tests at Harvest Park Middle School in Pleasanton, California, students' one-year pretest-posttest scores improved by 13 points after enacting a laptop program (Gulek & Demirtas, 2005). Gulek & Demirtas also found that grade point averages improved most for the laptop participants. Sixth-grade students who used laptop computers average grade point average (GPA) was

3.50, while non-laptop students' average GPA was 3.13. The same was found for students in the 7th-grade where the average GPA was 3.28 with laptop computer use and the average GPA was 2.94 with no laptop computer use. The average GPA for 8th-grade students was 3.23 with laptop computer use and the average GPA was 3.07 for 8th-grade students with no laptop computer use. In another study that focused on elementary students, the use of laptop computers improved girls' and boys' math and reading scores equally (Hargis & Schofield, 2006).

Interest in technology in the elementary grades is increasing, while in the past the focus has been on the secondary level. This shift is occurring at a rapid rate, and elementary schools are purchasing technology hardware and software at an ever-escalating rate (Penuel, 2006).

If true that students need to have daily access to computers to have an "...equal shot at learning," (Wambach, 2006, p. 59) this may be a promising trend. As recently as 2000 there were approximately 1000 schools in the United States using a 1:1 model (one computer to one student) totaling over 150,000 computers (Johnstone, 2003). In a 2007 school survey almost 73% of school districts reported that one-to-one laptop programs are now in operation in at least one of their schools and this number is growing

(Extracurricular, T.H.E. Journal, 2008). The need to understand how the added technology acquisitions will affect learning is obvious, and the ubiquitous presence of laptops in the elementary school will undoubtedly have an impact on classrooms, and ultimately on achievement.

Computer Use in the Future

Technology is not a fad, and a prepared knowledgeable worker who can make the best use of modern tools is much in demand. Today, students without the necessary and expected technology skills will struggle and ultimately need remedial technology training--training that could have, and should have, been made available early in a student's school years (Partnership for 21st Century Skills, 2007). If a prepared, technologically knowledgeable worker entering the work place is vital, and some children are not exposed to technology at school and home now, how does the Digital Divide Learner gain the skills that the Digital Native Learner has already practiced at home? The merger of schools and technology must be the answer. Remedial technology training will never be enough.

CHAPTER THREE

Research Methods

The purpose of this study was to determine the effect of a yearlong one-to-one laptop computer classroom program on the writing, reading, and technology outcomes of 4th-grade digital divide learners from homes without computer access compared to the writing, reading, and technology outcomes of 4th-grade digital native learners from homes with computer access who also participated in the yearlong one-to-one laptop computer classroom program.

Participants

Students and teachers participating were from two 4th-grade classrooms of the urban school chosen. 92% of the students qualified for free and reduced lunch, which was very close to the school-wide 90%. The mobility rate for this school was 23% for the previous school year.

Number of participants. Twenty-five students took part in this study ($N = 25$) from two classrooms. Study participants consisted of two naturally formed groups, ten were classified as Digital Divide Learners, or DDLs, who did not have access to computers and the Internet at home 1st-grade through the 3rd-grade ($n = 10$, 40% of participants) and fifteen were classified as Digital Native Learners, or DNLs, who did have access to computers and the

Internet at home 1st-grade through the 3rd-grade ($n = 15$, 60% of participants).

Gender of participants. Participants were 56% female ($n = 14$), and 44% male ($n = 11$). These numbers were somewhat different than the district gender averages for 4th-grade, which were 46% female and 54% male.

Age range of participants. All students in the study were from ages nine to eleven and completed 4th-grade at the end of the 2007-2008 school year.

Racial and ethnic origin of participants. Of the total number of participants ($N = 25$), 76% were Black, not Hispanic ($n = 19$), 8% were White, not Hispanic ($n = 2$), and 16% were Hispanic ($n = 4$). There were no American Indian or Asian or Pacific Islanders in the classrooms. These numbers were representative of the overall student population of the school.

Method of participant identification. All of the participants ($N = 25$) were enrolled in the 4th-grade in the same school and remained during the entire year of the study. Code numbers were used to track and identify DDLs and DNLs to correlate all pretest and posttest scores. No students were identified by name and no information was released beyond the scope of this study.

The study analyzed data from the Omaha Public School District's 4th-grade Writing Assessment tests, California Achievement Test scores in reading, teacher-evaluated technology skills domain scores, and electronically recorded keyboarding speed and keyboarding accuracy scores.

Description of Procedures

Research design. The pretest-posttest two-group comparative survey design is displayed in the following notation:

Group 1 X_1 O_1 X_2 O_2

Group 2 X_1 O_1 X_3 O_2

Group 1 = naturally formed group of 4th-grade students identified as digital-divide learners (DDLs) who have not had the use of computers at home 1st-grade through 3rd-grade ($n = 10$)

Group 2 = naturally formed group of 4th-grade students identified as digital-native learners (DNLs) who have had the use of computers at home 1st-grade through 3rd-grade ($n = 15$)

X_1 = all research study ($N = 25$) students participating in the one-to-one laptop computer classroom program throughout the 4th-grade school year

X_2 = digital divide learners (DDLs) who have not had access to computers at home 1st-grade through 3rd-grade

X_3 = digital native learners (DNLs) who have had access to computers at home 1st-grade through 3rd-grade

O_1 = Pretest (1) beginning 4th-grade achievement: (a) Omaha Public Schools District Writing Assessment pre-test scores, (b) California Achievement Tests Reading NCE scores for (i) vocabulary and (ii) comprehension. Pretest (2) beginning 4th-grade technology: (a) teacher-evaluated student technology skills domain scores (see appendix A) and (b) electronically recorded keyboarding skills for (i) speed and (ii) accuracy.

O_2 = Posttest (1) ending 4th-grade achievement: (a) Omaha Public Schools District Writing Assessment post-test scores, (b) California Achievement Tests Reading NCE scores for (i) vocabulary and (ii) comprehension. Posttest (2) ending 4th-grade technology: (a) teacher-evaluated student technology skills domain scores and (b) electronically recorded keyboarding skills for (i) speed and (ii) accuracy.

Independent Variable Descriptions

The independent variables were digital divide learners (DDLs), 4th-grade students who have not had access to home computers and the Internet from the 1st-grade through the 3rd-grade and digital native learners (DNLs), 4th-grade students who have had access to home computers and the

Internet from the 1st-grade through the 3rd-grades. The two groups were mixed in two classrooms and were at no time differentiated in any way. This was the students' first year with access to school laptop computers. The same district-approved curriculum was used throughout the school year.

The 2007-2008 school year was year three of the one-to-one laptop computer pilot in the school and teachers in the two classrooms had the same technology training with on-going district support. Teachers introduced the laptop computers to students in September of the school year and used them in all curriculum areas.

Dependent Variable Descriptions

Dependent variables included: Omaha Public Schools District Writing Assessment 4th-grade scores, California Achievement Tests NCE scores for Reading (a) vocabulary and (b) comprehension, teacher-evaluated student technology skills rubric scores, and keyboarding skills for speed and accuracy. A more in-depth description follows.

The District Writing Assessment 4th-grade test scores are administered in the fall and submitted to the Curriculum and Learning Department for rating. The students write on a topic prompt such as, "Think about a time when you helped someone." Trained teacher evaluators rated the

papers with evaluation criteria focusing on the following areas: ideas, organization, voice, word choice, sentence fluency, and conventions. Each paper was rated and was scored by two evaluators. Total scores, made up of the combined scores from the two raters ranged from 0 to 8. A third rater was asked to evaluate a paper if the two scores were not numerically close or the same. A score of "0" is given if one or more of the following conditions occur:

- The sample was not written in a narrative mode
- Paper is illegible
- Paper is written in a language other than English
- Paper does not contain sufficient content

Performance levels for total scores are as follows: 1-2 = Beginning, 3-5 = Progressing, 6 = Proficient, and 7-8 = Advanced. The process is repeated in the spring to identify achievement and improvement.

The California Achievement Tests, Fifth Edition (*CAT/5*) reading scores for comprehension and vocabulary are also compiled from the fall tests and spring tests. The *CAT/5* norm-referenced tests allow OPS to compare student achievement with that of a representative national group, and are displayed in percentile ranks. The 50th percentile ranking is the midpoint, and half of the students in the national norm group scored above the 50th percentile, while

half of the students in the national norm group scored at or below the 50th percentile.

The teacher-evaluated student technology skills rubric scores consists of five observed skills: (1) basic laptop computer and technology use, (2) application and Internet use, (3) comfort level/attitude about using technology, (4) communication, and (5) word processing (See Appendix A). The student's observed skill levels were tallied by the teacher on a scale of 0 to 3 in each of the five areas. Total points were between 0 and 15, with 15 being the very highest level. The rubric was completed in the fall to provide a skills baseline and again in the spring to monitor technology skills growth.

Students were asked to complete a web-based keyboarding skills evaluation in the fall and in the spring (<http://www.typingtest.com>). The three-minute test computes speed and accuracy.

Research Questions

The following research questions were used to analyze the 4th-grade achievement outcomes of Digital Divide Learners (DDL) and Digital Native Learners (DNL) following participation in a yearlong one-to-one laptop computer classroom program.

Overarching Pretest-Posttest Achievement Research

Question #1: Do DDLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade District Writing Assessment scores following participation in a one-to-one laptop computer classroom program?

Sub-Question 1a. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade District Writing Assessment scores following participation in a one-to-one laptop computer classroom program?

Research Sub-Question #1a was analyzed using dependent *t* tests to examine the significance of the difference between DDLs' beginning 4th-grade compared to ending 4th-grade District Writing Assessment scores following participation in a one-to-one laptop computer classroom program. Because multiple statistical tests will be conducted, a one-tailed .01 alpha level will be employed to help control for Type 1 errors. Means and standard deviations will be displayed in tables.

Overarching Pretest-Posttest Achievement Research

Question #2: Do DNLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade District Writing Assessment scores following participation in a one-to-one laptop computer classroom program?

Sub-Question 2a. Is there a statistically significant difference between DNLs' beginning 4th-grade compared to ending 4th-grade District Writing Assessment scores following participation in a one-to-one laptop computer classroom program?

Research Sub-Question #2a was analyzed using dependent *t* tests to examine the significance of the difference between DDLs' beginning 4th-grade compared to ending 4th-grade District Writing Assessment scores following participation in a one-to-one laptop computer classroom program. Because multiple statistical tests will be conducted, a one-tailed .01 alpha level will be employed to help control for Type 1 errors. Means and standard deviations will be displayed in tables.

Overarching Posttest-Posttest Achievement Research Question #3: Do DDLs have congruent or different ending 4th-grade District Writing Assessment scores compared to DNLs ending 4th-grade District Writing Assessment scores?

Sub-Question 3a. Is there a statistically significant difference between DDLs' ending 4th-grade District Writing Assessment compared to DNLs' ending 4th-grade District Writing Assessment scores following participation in a one-to-one laptop computer classroom program?

Research Sub-Question #3a was analyzed using independent *t* tests to examine the significance of the difference between DDLs' ending 4th-grade compared to DNLs' ending 4th-grade District Writing Assessment scores following participation in a one-to-one laptop computer classroom program. Because multiple statistical tests will be conducted, a one-tailed .01 alpha level will be employed to help control for Type 1 errors. Means and standard deviations will be displayed in tables.

Overarching Pretest-Posttest Achievement Research Question #4: Do DDLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade norm-referenced California Achievement Test CAT/5 NCE scores for (a) vocabulary and (b) reading comprehension, following participation in a one-to-one laptop computer classroom program?

Sub-Question 4a. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade Test CAT/5 NCE scores for (a) vocabulary following participation in a one-to-one laptop computer classroom program?

Sub-Question 4b. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade Test CAT/5 NCE scores for (b)

reading comprehension following participation in a one-to-one laptop computer classroom program?

Research Sub-Questions #4a and 4b were analyzed using dependent *t* tests to examine the significance of the difference between DDLs' beginning 4th-grade compared to ending 4th-grade norm-referenced California Achievement Test CAT/5 NCE scores for (a) vocabulary, and (b) comprehension following participation in a one-to-one laptop computer classroom. Because multiple statistical tests will be conducted, a one-tailed .01 alpha level will be employed to help control for Type 1 errors. Means and standard deviations will be displayed in tables.

Overarching Pretest-Posttest Achievement Research Question #5: DNLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade norm-referenced California Achievement Test CAT/5 NCE scores for (a) vocabulary and (b) reading comprehension following participation in a one-to-one laptop computer classroom program?

Sub-Question 5a. Is there a statistically significant difference between DNLs' beginning 4th-grade compared to ending 4th-grade Test CAT/5 NCE scores for (a) vocabulary following participation in a one-to-one laptop computer classroom program?

Sub-Question 5b. Is there a statistically significant difference between DNLs' beginning 4th-grade compared to ending 4th-grade Test CAT/5 NCE scores for (b) reading comprehension following participation in a one-to-one laptop computer classroom program?

Research Sub-Questions #5a and 5b were analyzed using dependent *t* tests to examine the significance of the difference between DNLs' beginning 4th-grade compared to ending 4th-grade norm-referenced California Achievement Test CAT/5 NCE scores for (a) vocabulary, and (b) comprehension following participation in a one-to-one laptop computer classroom. Because multiple statistical tests will be conducted, a one-tailed .01 alpha level will be employed to help control for Type 1 errors. Means and standard deviations will be displayed in tables.

Overarching Posttest-Posttest Achievement Research Question #6: Do DDLs' have congruent or different ending 4th-grade norm-referenced California Achievement Test (CAT/5) NCE scores for (a) vocabulary, and (b) reading comprehension compared to DNLs' ending 4th-grade norm-referenced California Achievement Test (CAT/5) NCE scores for (a) vocabulary, and (b) reading comprehension following participation in a one-to-one laptop computer classroom program?

Sub-Question 6a. Is there a statistically significant difference between DDLs' ending 4th-grade CAT/5 NCE scores for (a) vocabulary compared to DNLs' ending 4th-grade CAT/5 NCE scores for (a) vocabulary following participation in a one-to-one laptop computer classroom program?

Sub-Question 6b. Is there a statistically significant difference between DDLs' ending 4th-grade CAT/5 NCE scores for (b) reading comprehension compared to DNLs' ending 4th-grade CAT/5 NCE scores for (b) reading comprehension following participation in a one-to-one laptop computer classroom program?

Research Sub-Question #6a and 6b, were analyzed using independent *t* tests to examine the significance of the difference between DDLs' ending norm-referenced California Achievement Test (CAT/5) NCE scores for (a) vocabulary, and (b) comprehension compared to DNLs' ending norm-referenced California Achievement Test (CAT/5) NCE scores for (a) vocabulary and (b) comprehension following participation in a one-to-one laptop computer classroom program. Because multiple statistical tests will be conducted, a one-tailed .01 alpha level will be employed to help control for Type 1 errors. Means and standard deviations will be displayed in tables.

The following research questions were used to analyze the 4th-grade technology outcomes of Digital Divide Learners (DDL) and Digital Native Learners (DNL) following participation in a yearlong one-to-one laptop computer classroom program.

Overarching Pretest-Posttest Technology Research Question #7: Do DDLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom?

Sub-Question 7a. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom?

Research Sub-Question #7a was analyzed using dependent *t* tests to examine the significance of the difference between DDLs' beginning 4th-grade compared to ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom. Because multiple statistical tests will be conducted, a one-tailed .01 alpha level will be employed to help control for Type 1 errors. Means and standard deviations will be displayed in tables.

Overarching Pretest-Posttest Technology Research

Question #8: Do DNLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom?

Sub-Question 8a. Is there a statistically significant difference between DNLs' beginning 4th-grade compared to ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom?

Sub-Question #8a was analyzed using dependent *t* tests to examine the significance of the difference between DNLs' beginning 4th-grade compared to ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom. Because multiple statistical tests will be conducted, a one-tailed .01 alpha level will be employed to help control for Type 1 errors. Means and standard deviations will be displayed in tables.

Overarching Posttest-Posttest Technology Research

Question #9: Do DDLs have congruent or different ending 4th-grade teacher-evaluated student technology skills rubric scores compared to DNLs' ending 4th-grade teacher-evaluated student technology skills rubric scores following

participation in a one-to-one laptop computer classroom program?

Sub-Question 9a. Is there a statistically significant difference between DDLs' ending 4th-grade teacher-evaluated student technology skills rubric scores compared to DNLs' ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom program?

Sub-Question #9a was analyzed using independent t tests to examine the significance of the difference between DDLs' ending 4th-grade teacher-evaluated student technology skills rubric scores compared to DNLs' ending 4th-grade teacher-evaluated student technology skills rubric scores following participation in a one-to-one laptop computer classroom program. Because multiple statistical tests will be conducted, a one-tailed .01 alpha level will be employed to help control for Type 1 errors. Means and standard deviations will be displayed in tables.

Overarching Pretest-Posttest Technology Research Question #10: Do DDLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade keyboarding scores for (a) speed, and (b) accuracy

following participation in a one-to-one laptop computer classroom program?

Sub-Question 10a. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade keyboarding scores for (a) speed following participation in a one-to-one laptop computer classroom?

Sub-Question 10b. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade keyboarding scores for (b) accuracy following participation in a one-to-one laptop computer classroom?

Research Sub-Questions #10a and 10b were analyzed using dependent *t* tests to examine the significance of the difference between DDLs' beginning 4th-grade compared to ending 4th-grade keyboarding scores for (b) accuracy following participation in a one-to-one laptop computer classroom program. Because multiple statistical tests will be conducted, a one-tailed .01 alpha level will be employed to help control for Type 1 errors. Means and standard deviations will be displayed in tables.

Overarching Pretest-Posttest Technology Research Question #11: Do DDLs lose, maintain, or improve their beginning 4th-grade compared to ending 4th-grade

keyboarding scores for (a) speed, and (b) accuracy following participation in a one-to-one laptop computer classroom program?

Sub-Question 11a. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade keyboarding scores for (a) speed following participation in a one-to-one laptop computer classroom program?

Sub-Question 11b. Is there a statistically significant difference between DDLs' beginning 4th-grade compared to ending 4th-grade keyboarding scores for (b) accuracy following participation in a one-to-one laptop computer classroom program?

Research Sub-Questions #11a and 11b were analyzed using dependent *t* tests to examine the significance of the difference between DDLs' beginning 4th-grade compared to ending 4th-grade keyboarding scores for (b) accuracy following participation in a one-to-one laptop computer classroom program. Because multiple statistical tests will be conducted, a one-tailed .01 alpha level will be employed to help control for Type 1 errors. Means and standard deviations will be displayed in tables.

Overarching Posttest-Posttest Technology Research
Question #12: Do DDLs have congruent or different ending

4th-grade keyboarding scores compared to DNLs' ending 4th-grade keyboarding scores for (a) speed and (b) accuracy following participation in a one-to-one laptop computer classroom program?

Sub-Question 12a. Is there a statistically significant difference between DDLs' ending 4th-grade keyboarding scores compared to DNLs' ending 4th-grade keyboarding scores for (a) speed following participation in a one-to-one laptop computer classroom program?

Sub-Question 12b. Is there a statistically significant difference between DDLs' ending 4th-grade keyboarding scores compared to DNLs' ending 4th-grade keyboarding scores for (b) accuracy following participation in a one-to-one laptop computer classroom program?

Research Sub-Questions #12a and 12b were analyzed using independent *t* tests to examine the significance of the difference between DNLs' ending 4th-grade compared to DDLs' ending 4th-grade keyboarding scores for (b) accuracy following participation in a one-to-one laptop computer classroom program. Because multiple statistical tests will be conducted, a one-tailed .01 alpha level will be employed to help control for Type 1 errors. Means and standard deviations will be displayed in tables.

Data Collection Procedures

All student achievement and technology skills data was retrospectively collected and archived school information. Permission from the Research Department of the Omaha Public Schools was obtained in writing for beginning 4th-grade and ending 4th-grade California Achievement Test scores for reading, and beginning 4th-grade and ending 4th-grade District Writing Assessment scores. Scores were saved in an Excel spreadsheet. Beginning 4th-grade and ending 4th-grade teacher-evaluated student technology skills rubric scores were collected in September of 2007 and in May of 2008. Those scores were tabulated on the spreadsheet. Beginning 4th-grade and ending 4th-grade keyboarding skills for (a) speed and (b) accuracy were collected in September of 2007 and in May of 2008, as well. Aggregated group data, descriptive statistics, and inferential analyses were utilized. Means and standard deviations are displayed in tables.

Performance site. The research was conducted in the public school setting through normal educational practices. The study procedure did not interfere in any way with the normal educational practices of the public school and did not involve coercion or discomfort of any kind. All data was analyzed in the office of the primary investigator at

the Teachers' Administration Building (TAC) of the Omaha Public Schools, located at 3215 Cuming Street, Omaha, Nebraska, 68131. All data was stored on spreadsheets and flash drives for statistical analysis. All data remains stored on the researcher's computer, backed up on flash drives, and password protected.

Confidentiality. Non-coded numbers were used to display individual achievement and technology skills scores. The study data was not de-identified until all student information is linked and data sets were complete. When all information was tabulated the students were de-identified so no individual students could be identified.

Human Subjects Approval Category

The Combined University of Nebraska Medical Center/University of Nebraska at Omaha, Institutional Review Board for the Protection of Human Subjects, exemption categories for this study were provided under 45FR46.101(b) categories 1 and 4. The research was conducted using routinely collected archival data. A letter of support from the school district is located in Appendix B.

CHAPTER FOUR

Results

Purpose of the Study

The purpose of this study was to determine the effect of a yearlong one-to-one laptop computer classroom program on the writing, reading, and technology outcomes of 4th-grade digital divide learners from homes without computer access compared to the writing, reading, and technology outcomes of 4th-grade digital native learners from homes with computer access who also participated in the yearlong one-to-one laptop computer classroom program. The study analyzed writing and reading achievement scores, technology skills domain scores, and computer keyboarding speed and accuracy scores of 4th-grade digital divide learners from homes without computer access compared to 4th-grade digital native learners from homes with computer access to determine pretest-posttest intervention gain across time and compare the posttest-posttest scores of digital divide learners and digital native learners to determine intervention effectiveness.

The study analyzed the following dependent variables and measures: California Achievement Tests NCE scores for Reading (a) vocabulary and (b) comprehension, Omaha Public Schools District Writing Assessment 4th-grade scores,

teacher-evaluated student technology skills domain scores, and electronically recorded keyboarding scores for speed and accuracy. A more in-depth description follows.

The District Writing Assessment 4th-grade test scores are administered in the fall and submitted to the Curriculum and Learning Department for rating. The students write on a topic prompt such as, "Think about a time when you helped someone." Trained teacher evaluators rated the papers with evaluation criteria focusing on the following areas: ideas, organization, voice, word choice, sentence fluency, and conventions. Each paper was rated and scored by two evaluators. Total scores, made up of the combined scores from the two raters ranged from 0 to 8. A third rater was asked to evaluate a paper if the two scores were not numerically close or the same. A score of "0" is given if one or more of the following conditions occur:

- The sample was not written in a narrative mode
- Paper is illegible
- Paper is written in a language other than English
- Paper does not contain sufficient content

Performance levels for total scores are as follows: 1-2 = Beginning, 3-5 = Progressing, 6 = Proficient, and 7-8 = Advanced. The process is repeated in the spring to identify achievement and improvement.

The California Achievement Tests, Fifth Edition (*CAT/5*) reading scores for comprehension and vocabulary are also compiled from the fall tests and spring tests. The *CAT/5* norm-referenced tests allow OPS to compare student achievement with that of a representative national group, and are displayed in percentile ranks. The 50th percentile ranking is the midpoint, and half of the students in the national norm group scored above the 50th percentile, while half of the students in the national norm group scored at or below the 50th percentile. Pretest and posttest data for this study were available only from the comprehension and vocabulary portions of the tests for all student participants.

The teacher-evaluated student technology skills domain scores consists of five observed skills: (1) basic laptop computer and technology use, (2) application and Internet use, (3) comfort level/attitude about using technology, (4) communication, and (5) word processing (See Appendix A). The students' observed skill levels were tallied by the teacher on a scale of 0 to 3 in each of the five areas. Total points were between 0 and 15, with 15 being the very highest level. The rubric was completed in the fall to provide a skills baseline and again in the spring to monitor intervention effectiveness.

Students were asked to complete a web-based keyboarding skills evaluation in the fall and in the spring (<http://www.typingtest.com>). The three-minute test computed speed in words per minute and accuracy by percentage of words keyed correctly.

Student Demographics

Table 1 displays gender information of individual 4th-grade digital divide learners including their school-wide eligibility percentage for free or reduced-price meals and if a student has a minority status designation. Table 2 displays gender information of individual 4th-grade digital native learners including their school-wide eligibility percentage for free or reduced-price meals and if a student has a minority status designation. Individual 4th-grade digital divide learners California Achievement Test reading vocabulary and reading comprehension Normal Curve Equivalent scores are displayed in Table 3. Individual 4th-grade digital native learners California Achievement Test reading vocabulary and reading comprehension Normal Curve Equivalent scores are displayed in Table 4.

Research Question #1

The first hypothesis was tested using the dependent *t* test. Tests analyzed digital divide learners beginning 4th-grade pretest compared to ending 4th-grade posttest

California Achievement Test reading vocabulary and reading comprehension Normal Curve Equivalent scores. Results were displayed in Table 5. As seen in Table 5, the null hypothesis was not rejected for the two reading achievement tests, reading vocabulary and reading comprehension. The pretest reading vocabulary score ($M = 36.90$, $SD = 21.17$) compared to the posttest reading vocabulary score ($M = 43.50$, $SD = 15.96$) was not statistically significantly different, $t(9) = 1.20$, $p = .13$ (one-tailed), $d = .35$. The pretest reading comprehension score ($M = 38.30$, $SD = 14.06$) compared to the posttest reading comprehension score ($M = 39.00$, $SD = 15.68$), was not statistically significantly different, $t(9) = 0.16$, $p = .44$ (one-tailed), $d = .04$.

Overall, pretest-posttest results indicated that DDL did not statistically significantly improve their posttest reading vocabulary NCE score and did not statistically significantly improve their posttest reading comprehension NCE score. The null hypothesis was not rejected for either reading pretest-posttest comparison. Comparing DDLs' norm-referenced test NCE scores with derived achievement scores puts their performance in perspective. An NRT NCE posttest reading vocabulary mean score of 36.90 is congruent with a standard score of 90, a percentile rank of 25, a stanine score of 4, the lowest stanine in the average range, and a

descriptive designation of average. An NRT NCE posttest reading comprehension mean score of 38.30 is congruent with a standard score of 91, a percentile rank of 27, a stanine score of 4, the lowest stanine in the average range, and a descriptive designation of average. While DDLs' pretest-posttest reading vocabulary and reading comprehension scores were not statistically significantly different positive gain over time was observed for reading vocabulary and reading comprehension mean scores.

Research Question #2

The second hypothesis was tested using the dependent *t* test. Tests analyzed digital native learners beginning 4th-grade pretest compared to ending 4th-grade posttest California Achievement Test reading vocabulary and reading comprehension Normal Curve Equivalent scores. Results were displayed in Table 6. As seen in Table 6, the null hypothesis was rejected for one of the reading achievement tests, reading vocabulary, however, the null hypothesis was not rejected for the second reading achievement test, reading comprehension. The pretest reading vocabulary score ($M = 40.73$, $SD = 11.90$) compared to the posttest reading vocabulary score ($M = 47.67$, $SD = 13.94$) was statistically significantly different, $t(14) = 2.31$, $p = .02$ (one-tailed), $d = .51$. The pretest reading comprehension score

($M = 37.43$, $SD = 13.18$) compared to the posttest reading comprehension score ($M = 43.79$, $SD = 14.86$), was not statistically significantly different, $t(14) = 1.55$, $p = .07$ (one-tailed), $d = .45$.

Overall, pretest-posttest results indicated that DNLs did statistically significantly improve their posttest reading vocabulary NCE score and did not statistically significantly improve their posttest reading comprehension NCE score. The null hypothesis was rejected for reading vocabulary pretest-posttest gain but the null hypothesis was not rejected for reading comprehension pretest-posttest gain. Comparing DNLs' norm-referenced test NCE scores with derived achievement scores puts their performance in perspective. An NRT NCE posttest reading vocabulary mean score of 47.67 is congruent with a standard score of 98, a percentile rank of 45, a stanine score of 5, the middle stanine in the average range, and a descriptive designation of average. An NRT NCE posttest reading comprehension mean score of 43.79 is congruent with a standard score of 95, a percentile rank of 37, a stanine score of 4, the lowest stanine in the average range, and a descriptive designation of average. While DNLs' pretest-posttest reading vocabulary score was statistically significantly different and their reading comprehension score was not statistically

significantly different positive gain over time was observed for both reading vocabulary and reading comprehension mean scores.

Research Question #3

The third hypothesis was tested using the independent *t* test. Tests compared digital divide learners ending 4th-grade posttest California Achievement Test reading vocabulary and reading comprehension Normal Curve Equivalent scores compared to digital native learners ending 4th-grade posttest California Achievement Test reading vocabulary and reading comprehension Normal Curve Equivalent scores. Results were displayed in Table 7. As seen in Table 7, the null hypothesis was not rejected for the two reading achievement subtests reading vocabulary and reading comprehension. The DDLs' reading vocabulary posttest score ($M = 43.50$, $SD = 15.96$) compared to the DNLs' reading vocabulary posttest score ($M = 47.67$, $SD = 13.94$) was not statistically significantly different, $t(23) = 0.69$, $p = .25$ (one-tailed), $d = .27$. The DDLs' reading comprehension posttest score ($M = 39.00$, $SD = 15.68$) compared to the DNLs' reading comprehension posttest score ($M = 43.79$, $SD = 14.86$) was not statistically significantly different, $t(23) = 0.76$, $p = .23$ (one-tailed), $d = .31$.

Overall, posttest-posttest results indicated that

while DNLs' posttest reading vocabulary and reading comprehension mean scores were numerically greater DNLs and DDLs did not perform statistically significantly differently on the reading norm-referenced achievement measures. The null hypothesis was not rejected for the reading vocabulary and the reading comprehension posttest-posttest comparisons.

Research Question #4

Individual 4th-grade digital divide learners District Wide Writing Test scores are displayed in Table 8.

Individual 4th-grade digital native learners District Wide Writing Test scores are displayed in Table 9.

The fourth hypothesis was tested using the dependent t test. The test analyzed digital divide learners beginning 4th-grade pretest compared to ending 4th-grade posttest District Wide Writing Test scores. Results were displayed in Table 10. As seen in Table 10, the null hypothesis was not rejected for the writing achievement test. The pretest writing score ($M = 4.30$, $SD = 0.82$) compared to the posttest writing score ($M = 4.40$, $SD = 1.17$) was not statistically significantly different, $t(9) = 0.36$, $p = .36$ (one-tailed), $d = .10$.

Overall, pretest-posttest results indicated that DDLs did not statistically significantly improve their posttest

District Wide Writing Test score. The null hypothesis was not rejected for writing pretest-posttest gain. Comparing DDLs' writing achievement score with writing achievement levels puts their performance in perspective. A writing score of 1 and 2 = Beginning, 3 to 5 = Progressing, 6 = Proficient, and 7 and 8 = Advanced. The DDLs' posttest writing mean score of 4.40 is congruent with Progressing level writing performance. DDLs' pretest-posttest writing score comparison was not statistically significantly different, however, slight positive gain was observed over time.

Research Question #5

The fifth hypothesis was tested using the dependent t test. The test analyzed digital native learners beginning 4th-grade pretest compared to ending 4th-grade posttest District Wide Writing Test scores. Results were displayed in Table 11. As seen in Table 11, the null hypothesis was not rejected for the writing achievement test. The pretest writing score ($M = 4.40$, $SD = 0.91$) compared to the posttest writing score ($M = 4.60$, $SD = 1.24$) was not statistically significantly different, $t(14) = 0.59$, $p = .28$ (one-tailed), $d = .18$.

Overall, pretest-posttest results indicated that DNLs did not statistically significantly improve their posttest

District Wide Writing Test score. The null hypothesis was not rejected for writing pretest-posttest gain. Comparing DNLs' writing achievement score with writing achievement levels puts their performance in perspective. A writing score of 1 and 2 = Beginning, 3 to 5 = Progressing, 6 = Proficient, and 7 and 8 = Advanced. The DNLs' posttest writing mean score of 4.60 is congruent with Progressing level writing performance. DNLs' pretest-posttest writing score comparison was not statistically significantly different, however, slight positive gain was observed over time.

Research Question #6

The sixth hypothesis was tested using the independent t test. Tests compared digital divide learners ending 4th-grade posttest District Wide Writing Test scores compared to digital native learners ending 4th-grade posttest District Wide Writing Test scores. Results were displayed in Table 12. As seen in Table 12, the null hypothesis was not rejected for the writing achievement tests. The DDLs' writing posttest score ($M = 4.40$, $SD = 1.17$) compared to the DNLs' writing posttest score ($M = 4.60$, $SD = 1.24$) was not statistically significantly different, $t(23) = 0.64$, $p = .27$ (one-tailed), $d = .26$.

Overall, posttest-posttest results indicated that while DNLs' posttest writing mean score was numerically greater DNLs and DDLs did not perform statistically significantly differently on the writing achievement measure. The null hypothesis was not rejected for the writing posttest-posttest comparisons.

Research Question #7

Individual 4th-grade digital divide learners' teacher evaluated total technology skills domain scores are displayed in Table 13. Individual 4th-grade digital native learners' teacher evaluated total technology skills domain scores are displayed in Table 14.

The seventh hypothesis was tested using the dependent *t* test. The test analyzed digital divide learners beginning 4th-grade pretest compared to ending 4th-grade posttest total technology skills domain scores. Total technology skills include: computer use, Internet use, computer attitude, communications, and word processing domain scores. The students' observed skill levels were tallied by the teacher on a scale of 0 to 3 in each of the five areas. Total points were between 0 and 15, with 15 being the very highest level.

Results were displayed in Table 15. As seen in Table 15, the null hypothesis was rejected for the total

technology skills domain scores. The pretest total technology skills domain scores ($M = 7.50, SD = 3.03$) compared to the posttest total technology skills domain scores ($M = 9.40, SD = 2.22$) was statistically significantly different, $t(9) = 2.75, p = .01$ (one-tailed), $d = 1.30$.

Overall, pretest-posttest results indicated that DDLs did statistically significantly improve their posttest total technology skills domain scores. The null hypothesis was rejected for total technology skills domain scores pretest-posttest gain. Total technology skills include: computer use, Internet use, computer attitude, communications, and word processing domain scores. The student's observed skill levels were tallied by the teacher on a scale of 0 to 3 in each of the five areas. Total points were between 0 and 15, with 15 being the very highest level. Comparing DDLs' total technology skills domain scores with technology achievement levels puts their performance in perspective. A total technology skills score of 1 to 4 = Beginning, 5 to 8 = Progressing, 9 to 12 = Proficient, and 13 through 15 = Advanced. The DDLs' posttest total technology skills score mean of 9.40 is congruent with a proficient level of technology performance. DDLs' pretest-posttest total technology skills

score comparison was statistically significantly different, with positive gain and a change of technology score nomenclature from pretest progressing to posttest proficient.

Research Question #8

The eighth hypothesis was tested using the dependent *t* test. The test analyzed digital native learners beginning 4th-grade pretest compared to ending 4th-grade posttest total technology skills domain scores. Total technology skills include: computer use, Internet use, computer attitude, communications, and word processing domain scores. The students' observed skill levels were tallied by the teacher on a scale of 0 to 3 in each of the five areas. Total points were between 0 and 15, with 15 being the very highest level.

Results were displayed in Table 16. As seen in Table 16, the null hypothesis was rejected for the total technology skills domain scores. The pretest total technology skills domain scores ($M = 7.80, SD = 2.08$) compared to the posttest total technology skills domain scores ($M = 9.87, SD = 2.03$) was statistically significantly different, $t(14) = 5.38, p < .0001$ (one-tailed), $d = 2.05$.

Overall, pretest-posttest results indicated that DNLs did statistically significantly improve their posttest total technology skills domain scores. The null hypothesis was rejected for total technology skills domain scores pretest-posttest gain. Total technology skills include: computer use, Internet use, computer attitude, communications, and word processing domain scores. The student's observed skill levels were tallied by the teacher on a scale of 0 to 3 in each of the five areas. Total points were between 0 and 15, with 15 being the very highest level. Comparing DNLs' total technology skills domain scores with technology achievement levels puts their performance in perspective. A total technology skills score of 1 to 4 = Beginning, 5 to 8 = Progressing, 9 to 12 = Proficient, and 13 through 15 = Advanced. The DNLs' posttest total technology skills score mean of 9.87 is congruent with a proficient level of technology performance. DNLs' pretest-posttest total technology skills score comparison was statistically significantly different, with positive gain and a change of technology score nomenclature from pretest progressing to posttest proficient.

Research Question #9

The ninth hypothesis was tested using the independent t test. Tests compared digital divide learners' ending 4th-grade posttest total technology skills domain scores compared to digital native learners' ending 4th-grade posttest total technology skills domain scores. Results were displayed in Table 17. As seen in Table 17, the null hypothesis was not rejected for the total technology skills domain scores. The DDLs' total technology skills domain scores ($M = 9.40$, $SD = 2.22$) compared to the DNLs' total technology skills domain scores ($M = 9.87$, $SD = 2.03$) was not statistically significantly different, $t(23) = 0.54$, $p = .30$ (one-tailed), $d = .22$.

Overall, posttest-posttest results indicated that while DNLs' posttest total technology skills domain scores were numerically greater, DNLs and DDLs did not perform statistically significantly differently on the technology skills measures. The null hypothesis was not rejected for the total technology skills domain scores comparisons.

Research Question #10

Individual 4th-Grade digital divide learners' electronically recorded keyboarding speed and keyboarding accuracy scores were displayed in Table 18. Individual 4th-grade digital native learners' electronically recorded

keyboarding speed and keyboarding accuracy scores were displayed in Table 19.

The tenth hypothesis was tested using the dependent t test. Tests analyzed digital divide learners' beginning 4th-grade pretest electronically recorded keyboarding speed and keyboarding accuracy scores compared to ending 4th-grade posttest electronically recorded keyboarding speed and keyboarding accuracy scores. Results were displayed in Table 20. As seen in Table 20, the null hypothesis was rejected for the two tests, keyboarding speed and keyboarding accuracy. The pretest electronically recorded keyboarding speed scores ($M = 2.40$, $SD = 1.07$) compared to the posttest electronically recorded keyboarding speed scores ($M = 12.40$, $SD = 4.86$) were statistically significantly different, $t(9) = 6.96$, $p < .0001$ (one-tailed), $d = 3.37$. The pretest electronically recorded keyboarding accuracy scores ($M = 65.40$, $SD = 22.23$) compared to the posttest electronically recorded keyboarding accuracy scores ($M = 84.20$, $SD = 10.29$), were statistically significantly different, $t(9) = 3.38$, $p = .004$ (one-tailed), $d = 1.15$.

Overall, pretest-posttest results indicated that DDLs did statistically significantly improve their posttest electronically recorded keyboarding speed scores and did

statistically significantly improve their posttest electronically recorded keyboarding accuracy scores following participation in the yearlong one-to-one laptop computer classroom program. The null hypothesis was rejected for both keyboarding speed and keyboarding accuracy pretest-posttest comparisons. Scores were determined by completion of a web-based electronically recorded keyboarding skills evaluation in the fall and in the spring (<http://www.typingtest.com>). The three-minute test computes speed in words per minute and accuracy by percentage of words keyed correctly.

Research Question #11

The eleventh hypothesis was tested using the dependent *t* test. Tests analyzed digital native learners' beginning 4th-grade pretest electronically recorded keyboarding speed and keyboarding accuracy scores compared to ending 4th-grade posttest electronically recorded keyboarding speed and keyboarding accuracy scores. Results were displayed in Table 21. As seen in Table 21, the null hypothesis was rejected for the two tests, keyboarding speed and keyboarding accuracy. The pretest electronically recorded keyboarding speed scores ($M = 3.00$, $SD = 2.17$) compared to the posttest electronically recorded keyboarding speed scores ($M = 14.53$, $SD = 4.66$) were statistically

significantly different, $t(14) = 14.04$, $p < .0001$ (one-tailed), $d = 3.39$. The pretest electronically recorded keyboarding accuracy scores ($M = 63.33$, $SD = 14.89$) compared to the posttest electronically recorded keyboarding accuracy scores ($M = 91.80$, $SD = 5.95$), were statistically significantly different, $t(14) = 6.15$, $p < .0001$ (one-tailed), $d = 2.73$.

Overall, pretest-posttest results indicated that DNLs did statistically significantly improve their posttest electronically recorded keyboarding speed scores and did statistically significantly improve their posttest electronically recorded keyboarding accuracy scores following participation in the yearlong one-to-one laptop computer classroom program. The null hypothesis was rejected for both keyboarding speed and keyboarding accuracy pretest-posttest comparisons. Scores were determined by completion of a web-based electronically recorded keyboarding skills evaluation in the fall and in the spring (<http://www.typingtest.com>). The three-minute test computes speed in words per minute and accuracy by percentage of words keyed correctly.

Research Question #12

The twelfth hypothesis was tested using the independent t test. Tests compared digital divide learners'

ending 4th-grade posttest electronically recorded keyboarding speed and keyboarding accuracy scores compared to digital native learners' ending 4th-grade posttest electronically recorded keyboarding speed and keyboarding accuracy scores. Results were displayed in Table 22. As seen in Table 22, the null hypothesis was not rejected for the posttest electronically recorded keyboarding speed scores. The DDLs' posttest electronically recorded keyboarding speed scores ($M = 12.40$, $SD = 4.86$) compared to the DNLs' posttest electronically recorded keyboarding speed scores ($M = 14.53$, $SD = 4.66$) were not statistically significantly different, $t(23) = 1.10$, $p = .14$ (one-tailed), $d = .44$. However, the null hypothesis was rejected for the posttest electronically recorded keyboarding accuracy scores. The DDLs' posttest electronically recorded keyboarding accuracy scores ($M = 84.20$, $SD = 10.29$) compared to the DNLs' posttest electronically recorded keyboarding accuracy scores ($M = 91.80$, $SD = 5.95$) were statistically significantly different, $t(23) = 2.34$, $p = .01$ (one-tailed), $d = .93$.

Overall, posttest-posttest results indicated that while DNLs' posttest electronically recorded keyboarding speed scores were numerically greater, DNLs and DDLs did not perform statistically significantly differently on the

keyboarding speed measures and the null hypothesis was not rejected for this comparison. However, DNLs' posttest electronically recorded keyboarding accuracy scores were numerically greater than the DNLs posttest electronically recorded keyboarding accuracy scores and the null hypothesis was rejected for the keyboarding accuracy comparison.

Table 1

Gender Information of Individual 4th-Grade Digital Divide Learners (a)

Student Number	Gender	Race	Free or Reduced Price Lunch Program
1.	Female	Hispanic	Yes
2.	Female	Black	Yes
3.	Female	Hispanic	Yes
4.	Male	Caucasian	Yes
5.	Male	Black	Yes
6.	Male	Hispanic	Yes
7.	Female	Black	Yes
8.	Female	Hispanic	Yes
9.	Female	Black	Yes
10.	Male	Black	Yes

(a) Note: No students with verified special education needs participated in this study.

Table 2

Gender Information of Individual 4th-Grade Digital Native Learners (a)

Student Number	Gender	Race	Free or Reduced Price Lunch Program
1.	Female	Black	Yes
2.	Female	Black	Yes
3.	Male	Caucasian	Yes
4.	Male	Black	Yes
5.	Female	Black	No
6.	Female	Black	Yes
7.	Male	Black	Yes
8.	Female	Black	No
9.	Female	Black	Yes
10.	Male	Black	Yes
11.	Female	Black	Yes
12.	Male	Black	Yes
13.	Female	Black	Yes
14.	Male	Black	Yes
15.	Male	Black	Yes

(a) Note: No students with verified special education needs participated in this study.

Table 3

*Individual 4th-Grade Digital Divide Learners California
Achievement Test Reading Vocabulary and Reading
Comprehension Normal Curve Equivalent Scores*

(a)	Reading Vocabulary		Reading Comprehension	
	Pre	Post	Pre	Post
1.	52	52	53	48
2.	52	45	50	51
3.	62	58	48	51
4.	47	32	39	37
5.	1	47	18	45
6.	31	50	40	26
7.	50	66	57	62
8.	42	37	18	36
9.	1	8	27	9
10.	31	40	33	25

(a) Note: Student numbers correspond with Table 1.

Table 4

*Individual 4th-Grade Digital Native Learners California
Achievement Test Reading Vocabulary and Reading
Comprehension Normal Curve Equivalent Scores*

(a)	Reading Vocabulary		Reading Comprehension	
	Pre	Post	Pre	Post
1.	42	61	40	68
2.	28	50	27	48
3.	28	27	33	21
4.	42	45	53	41
5.	50	27	53	62
6.	47	52	36	55
7.	24	30	34	37
8.	47	45	40	41
9.	59	73	45	55
10.	42	55	1	33
11.	54	66	52	50
12.	42	50	34	13
13.	50	55	40	44
14.	16	32	36	45
15.	40	47	40	55

(a) Note: Student numbers correspond with Table 2.

Table 5

*Digital Divide Learners Beginning 4th-Grade Pretest
Compared to Ending 4th-Grade Posttest California
Achievement Test Reading Vocabulary and Reading
Comprehension Normal Curve Equivalent Scores*

Source	Pretest Scores		Posttest Scores		<i>d</i>	<i>t</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
(a)	36.90	(21.17)	43.50	(15.96)	.35	1.20	.13*
(b)	38.30	(14.06)	39.00	(15.68)	.04	0.16	.44*

(a) Note: Reading Vocabulary.

(b) Note: Reading Comprehension.

**ns.*

Table 6

*Digital Native Learners Beginning 4th-Grade Pretest
Compared to Ending 4th-Grade Posttest California
Achievement Test Reading Vocabulary and Reading
Comprehension Normal Curve Equivalent Scores*

Source	Pretest Scores		Posttest Scores		<i>d</i>	<i>t</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
(a)	40.73	(11.90)	47.67	(13.94)	.51	2.31	.02**
(b)	37.43	(13.18)	43.79	(14.86)	.45	1.55	.07*

(a) Note: Reading Vocabulary.

(b) Note: Reading Comprehension.

ns.* *p* = .02.

Table 7

*Digital Divide Learners Ending 4th-Grade Posttest
California Achievement Test Reading Vocabulary and Reading
Comprehension Normal Curve Equivalent Scores Compared to
Digital Native Learners Ending 4th-Grade Posttest
California Achievement Test Reading Vocabulary and Reading
Comprehension Normal Curve Equivalent Scores*

Source	Digital Divide Learners Posttest		Digital Native Learners Posttest		<i>d</i>	<i>t</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
(a)	43.50	(15.96)	47.67	(13.94)	.27	0.69	.25*
(b)	39.00	(15.68)	43.79	(14.86)	.31	0.76	.23*

(a) Note: Reading Vocabulary.

(b) Note: Reading Comprehension.

**ns.*

Table 8

*Individual 4th-Grade Digital Divide Learners District Wide
Writing Test Scores*

(a)	Writing Scores (b)	
	Pretest	Posttest
1.	5	5
2.	4	5
3.	4	3
4.	6	5
5.	4	4
6.	4	5
7.	5	6
8.	4	5
9.	3	2
10.	4	4

(a) Note: Student numbers correspond with Table 1.

(b) Note: 1 and 2 = Beginning. 3 to 5 = Progressing. 6 = Proficient. 7 and 8 = Advanced.

Table 9

*Individual 4th-Grade Digital Native Learners District Wide
Writing Test Scores*

(a)	Writing Scores (b)	
	Pretest	Posttest
1.	6	5
2.	4	5
3.	3	2
4.	4	4
5.	6	4
6.	4	5
7.	4	4
8.	4	6
9.	4	7
10.	4	4
11.	6	5
12.	4	5
13.	4	4
14.	5	6
15.	4	3

(a) Note: Student numbers correspond with Table 2.

(b) Note: 1 and 2 = Beginning. 3 to 5 = Progressing. 6 = Proficient. 7 and 8 = Advanced.

Table 10

*Digital Divide Learners Beginning 4th-Grade Pretest
Compared to Ending 4th-Grade Posttest District Wide Writing
Test Scores*

Source	Pretest Scores		Posttest Scores		<i>d</i>	<i>t</i>	<i>p</i>
	M	SD	M	SD			
Writing	4.30	(0.82)	4.40	(1.17)	.10	0.36	.36*

**ns.*

Table 11

*Digital Native Learners Beginning 4th-Grade Pretest
Compared to Ending 4th-Grade Posttest District Wide Writing
Test Scores*

Source	Pretest Scores		Posttest Scores		<i>d</i>	<i>t</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Writing	4.40	(0.91)	4.60	(1.24)	.18	0.59	.28*

**ns.*

Table 12

Digital Divide Learners Ending 4th-Grade Posttest District Wide Writing Test Scores Compared to Digital Native Learners Ending 4th-Grade Posttest District Wide Writing Test Scores

Source	Digital Divide Learners Posttest		Digital Native Learners Posttest		<i>d</i>	<i>t</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Writing	4.40	(1.17)	4.60	(1.24)	.26	0.64	.27*

**ns.*

Table 13

*Individual 4th-Grade Digital Divide Learners Teacher
Evaluated Total Technology Skills Domain Scores*

(a)	Total Technology Skills (b)	
	Pretest	Posttest
1.	10	10
2.	7	9
3.	15	13
4.	6	11
5.	5	7
6.	6	9
7.	8	10
8.	6	11
9.	5	5
10.	7	9

(a) Note: Student numbers correspond with Table 1.

(b) Note: Total Technology Skills includes: (i) computer use, (ii) Internet use, (iii) computer attitude, (iv) communications, and (v) word processing domain scores.

Table 14

*Individual 4th-Grade Digital Native Learners Teacher
Evaluated Total Technology Skills Domain Scores*

(a)	Total Technology Skills (b)	
	Pretest	Posttest
1.	11	12
2.	8	8
3.	5	6
4.	7	7
5.	13	13
6.	5	9
7.	6	8
8.	8	11
9.	8	11
10.	7	11
11.	7	11
12.	8	9
13.	9	12
14.	8	11
15.	7	9

(a) Note: Student numbers correspond with Table 2.

(b) Note: Total Technology Skills includes: (i) computer use, (ii) Internet use, (iii) computer attitude, (iv) communications, and (v) word processing domain scores.

Table 15

*Digital Divide Learners Beginning 4th-Grade Pretest
Compared to Ending 4th-Grade Posttest Total Technology
Skills Domain Scores*

Source	Pretest Scores		Posttest Scores		<i>d</i>	<i>t</i>	<i>p</i>
	M	SD	M	SD			
(a)	7.50	(3.03)	9.40	(2.22)	1.30	2.75	.01*

(a) Note: Total Technology Skills includes: (i) computer use, (ii) Internet use, (iii) computer attitude, (iv) communications, and (v) word processing domain scores.

**p* = .01.

Table 16

*Digital Native Learners Beginning 4th-Grade Pretest
Compared to Ending 4th-Grade Posttest Total Technology
Skills Domain Scores*

Source	Pretest Scores		Posttest Scores		<i>d</i>	<i>t</i>	<i>p</i>
	M	SD	M	SD			
(a)	7.80	(2.08)	9.87	(2.03)	2.05	5.38	.0001*

(a) Note: Total Technology Skills includes: (i) computer use, (ii) Internet use, (iii) computer attitude, (iv) communications, and (v) word processing domain scores.

* $p < .0001$.

Table 17

Digital Divide Learners Ending 4th-Grade Total Technology Skills Domain Scores Compared to Digital Native Learners Ending 4th-Grade Posttest Total Technology Skills Domain Scores

Source	Digital Divide Learners Posttest		Digital Native Learners Posttest		<i>d</i>	<i>t</i>	<i>p</i>
	M	SD	M	SD			
(a)	9.40	(2.22)	9.87	(2.03)	.22	0.54	.30*

(a) Note: Total Technology Skills includes: (i) computer use, (ii) Internet use, (iii) computer attitude, (iv) communications, and (v) word processing domain scores.

**ns.*

Table 18

Individual 4th-Grade Digital Divide Learners Electronically Recorded Keyboarding Speed and Keyboarding Accuracy Scores

(a)	Keyboarding Speed (b)		Keyboarding Accuracy (c)	
	Pre	Post	Pre	Post
1.	4	20	80	95
2.	3	12	61	70
3.	2	19	60	89
4.	3	15	76	93
5.	2	8	52	86
6.	2	11	65	83
7.	1	13	31	82
8.	2	13	100	95
9.	1	4	37	64
10.	4	9	92	85

(a) Note: Student numbers correspond with Table 1.

(b) Note: Keyboarding Speed = words keyed per minute.

(c) Note: Keyboarding Accuracy = percent of words spelled correctly per minute.

Table 19

Individual 4th-Grade Digital Native Learners Electronically Recorded Keyboarding Speed and Keyboarding Accuracy Scores

(a)	Keyboarding Speed (b)		Keyboarding Accuracy (c)	
	Pre	Post	Pre	Post
1.	2	16	74	98
2.	2	9	66	96
3.	0	7	31	95
4.	4	20	73	82
5.	2	16	63	100
6.	2	10	52	86
7.	1	12	40	92
8.	8	26	86	88
9.	2	14	46	100
10.	5	18	67	88
11.	2	14	67	91
12.	3	13	72	87
13.	3	15	64	100
14.	7	16	73	87
15.	2	12	76	87

(a) Note: Student numbers correspond with Table 2.

(b and c) Note: See Table 18.

Table 20

*Digital Divide Learners Beginning 4th-Grade Pretest
Compared to Ending 4th-Grade Posttest Electronically
Recorded Keyboarding Speed and Keyboarding Accuracy Scores*

Source	Pretest Scores		Posttest Scores		<i>d</i>	<i>t</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
(a)	2.40	(1.07)	12.40	(4.86)	3.37	6.96	.0001**
(b)	65.40	(22.23)	84.20	(10.29)	1.15	3.38	.004*

(a) Note: Keyboarding Speed = words keyed per minute.

(b) Note: Keyboarding Accuracy = percent of words spelled correctly per minute.

p* = .004. *p* < .0001.

Table 21

*Digital Native Learners Beginning 4th-Grade Pretest
Compared to Ending 4th-Grade Posttest Electronically
Recorded Keyboarding Speed and Keyboarding Accuracy Scores*

Source	Pretest Scores		Posttest Scores		<i>d</i>	<i>t</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
(a)	3.00	(2.17)	14.53	(4.66)	3.39	14.04	.0001*
(b)	63.33	(14.89)	91.80	(5.95)	2.73	6.15	.0001*

(a) Note: Keyboarding Speed = words keyed per minute.

(b) Note: Keyboarding Accuracy = percent of words spelled correctly per minute.

* $p < .0001$.

Table 22

*Digital Divide Learners Ending 4th-Grade Posttest
Electronically Recorded Keyboarding Speed and Keyboarding
Accuracy Scores Compared to Digital Native Learners Ending
4th-Grade Posttest Electronically Recorded Keyboarding
Speed and Keyboarding Accuracy Scores*

Source	Digital Divide Learners Posttest		Digital Native Learners Posttest		<i>d</i>	<i>t</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
(a)	12.40	(4.86)	14.53	(4.66)	.44	1.10	.14*
(b)	84.20	(10.29)	91.80	(5.95)	.93	2.34	.01**

(a) Note: Keyboarding Speed = words keyed per minute.

(b) Note: Keyboarding Accuracy = percent of words spelled correctly per minute.

ns.* *p* = .01.

CHAPTER FIVE

Conclusions and Discussion

Purpose of the Study

The purpose of this study was to determine the effect of a yearlong one-to-one laptop computer classroom program on the writing, reading, and technology outcomes of 4th-grade digital divide learners from homes without computer access compared to the writing, reading, and technology outcomes of 4th-grade digital native learners from homes with computer access who also participated in the yearlong one-to-one laptop computer classroom program. The study analyzed writing and reading achievement scores, technology skills domain scores, and computer keyboarding speed and accuracy scores of 4th-grade digital divide learners from homes without computer access compared to 4th-grade digital native learners from homes with computer access to determine pretest-posttest intervention gain across time and compare the posttest-posttest scores of digital divide learners and digital native learners to determine intervention effectiveness.

All student pretest-posttest achievement and technology outcome data related to each of the dependent variables were retrospective, archival, and routinely collected school information. Permission from the

appropriate school research personnel and from the combined University of Nebraska Medical Center/University of Nebraska at Omaha Institutional Review Board for the Protection of Human Subjects was obtained before data were collected and analyzed.

This chapter contains the conclusions and discussion of the findings from this research effort. The chapter begins with the conclusions reached from calculating the data. The next section contains a discussion of those conclusions. The discussion includes an assessment of the significance of those findings. The discussion also includes recommendations for future research.

Conclusions

The following conclusions were drawn from the study for each of the twelve research questions.

Research question #1. Overall, pretest-posttest results indicated that DDLs did not statistically significantly improve their posttest reading vocabulary NCE score and did not statistically significantly improve their posttest reading comprehension NCE score. The null hypothesis was not rejected for either reading pretest-posttest comparison. Comparing DDLs' norm-referenced test NCE scores with derived achievement scores puts their performance in perspective. An NRT NCE posttest reading

vocabulary mean score of 36.90 is congruent with a standard score of 90, a percentile rank of 25, a stanine score of 4, the lowest stanine in the average range, and a descriptive designation of average. An NRT NCE posttest reading comprehension mean score of 38.30 is congruent with a standard score of 91, a percentile rank of 27, a stanine score of 4, the lowest stanine in the average range, and a descriptive designation of average. While DDLs' pretest-posttest reading vocabulary and reading comprehension scores were not statistically significantly different positive gain over time was observed for reading vocabulary and reading comprehension mean scores.

Research question #2. Overall, pretest-posttest results indicated that DNLs did statistically significantly improve their posttest reading vocabulary NCE score and did not statistically significantly improve their posttest reading comprehension NCE score. The null hypothesis was rejected for reading vocabulary pretest-posttest gain but the null hypothesis was not rejected for reading comprehension pretest-posttest gain. Comparing DNLs' norm-referenced test NCE scores with derived achievement scores puts their performance in perspective. An NRT NCE posttest reading vocabulary mean score of 47.67 is congruent with a standard score of 98, a percentile rank of 45, a stanine

score of 5, the middle stanine in the average range, and a descriptive designation of average. An NRT NCE posttest reading comprehension mean score of 43.79 is congruent with a standard score of 95, a percentile rank of 37, a stanine score of 4, the lowest stanine in the average range, and a descriptive designation of average. DNLs' pretest-posttest reading vocabulary score was statistically significantly different and their reading comprehension score was not statistically significantly different positive gain over time was observed for both reading vocabulary and reading comprehension mean scores.

Research question #3. Overall, posttest-posttest results indicated that while DNLs' posttest reading vocabulary and reading comprehension mean scores were numerically greater DNLs and DDLs did not perform statistically significantly differently on the reading norm-referenced achievement measures. The null hypothesis was not rejected for the reading vocabulary and the reading comprehension posttest-posttest comparisons.

Research question #4. Overall, pretest-posttest results indicated that DDLs did not statistically significantly improve their posttest district wide writing test score. The null hypothesis was not rejected for writing pretest-posttest gain. Comparing DDLs' writing

achievement score with writing achievement levels puts their performance in perspective. A writing score of 1 and 2 = beginning, 3 to 5 = progressing, 6 = proficient, and 7 and 8 = advanced. The DDLs' posttest writing mean score of 4.40 is congruent with progressing level writing performance. DDLs' pretest-posttest writing score comparison was not statistically significantly different, however, slight positive gain was observed over time.

Research question #5. Overall, pretest-posttest results indicated that DNLs did not statistically significantly improve their posttest district wide writing test score. The null hypothesis was not rejected for writing pretest-posttest gain. Comparing DNLs' writing achievement score with writing achievement levels puts their performance in perspective. A writing score of 1 and 2 = beginning, 3 to 5 = progressing, 6 = proficient, and 7 and 8 = advanced. The DNLs' posttest writing mean score of 4.60 is congruent with progressing level writing performance. DNLs' pretest-posttest writing score comparison was not statistically significantly different, however, slight positive gain was observed over time.

Research question #6. Overall, posttest-posttest results indicated that while DNLs' posttest writing mean score was numerically greater DNLs and DDLs did not perform

statistically significantly differently on the writing achievement measure. The null hypothesis was not rejected for the writing posttest-posttest comparisons.

Research question #7. Overall, pretest-posttest results indicated that DDLs did statistically significantly improve their posttest total technology skills domain scores. The null hypothesis was rejected for total technology skills domain scores pretest-posttest gain. Total technology skills include: computer use, Internet use, computer attitude, communications, and word processing domain scores. The student's observed skill levels were tallied by the teacher on a scale of 0 to 3 in each of the five areas. Total points were between 0 and 15, with 15 being the very highest level. Comparing DDLs' total technology skills domain scores with technology achievement levels puts their performance in perspective. A total technology skills score of 1 to 4 = beginning, 5 to 8 = progressing, 9 to 12 = proficient, and 13 through 15 = advanced. The DDLs' posttest total technology skills score mean of 9.40 is congruent with a proficient level of technology performance. DDLs' pretest-posttest total technology skills score comparison was statistically significantly different, with positive gain and a change of

technology score nomenclature from pretest progressing to posttest proficient.

Research question #8. Overall, pretest-posttest results indicated that DNLs did statistically significantly improve their posttest total technology skills domain scores. The null hypothesis was rejected for total technology skills domain scores pretest-posttest gain. Total technology skills include: computer use, Internet use, computer attitude, communications, and word processing domain scores. The student's observed skill levels were tallied by the teacher on a scale of 0 to 3 in each of the five areas. Total points were between 0 and 15, with 15 being the very highest level. Comparing DNLs' total technology skills domain scores with technology achievement levels puts their performance in perspective. A total technology skills score of 1 to 4 = Beginning, 5 to 8 = Progressing, 9 to 12 = Proficient, and 13 through 15 = Advanced. The DNLs' posttest total technology skills score mean of 9.87 is congruent with a proficient level of technology performance. DNLs' pretest-posttest total technology skills score comparison was statistically significantly different, with positive gain and a change of technology score nomenclature from pretest progressing to posttest proficient.

Research question #9. Overall, posttest-posttest results indicated that while DNLs' posttest total technology skills domain scores were numerically greater, DNLs and DDLs did not perform statistically significantly differently on the technology skills measures. The null hypothesis was not rejected for the total technology skills domain scores comparisons.

Research question #10. Overall, pretest-posttest results indicated that DDLs did statistically significantly improve their posttest electronically recorded keyboarding speed scores and did statistically significantly improve their posttest electronically recorded keyboarding accuracy scores following participation in the yearlong one-to-one laptop computer classroom program. The null hypothesis was rejected for both keyboarding speed and keyboarding accuracy pretest-posttest comparisons. Scores were determined by completion of a web-based electronically recorded keyboarding skills evaluation in the fall and in the spring. The three-minute test computes speed in words per minute and accuracy by percentage of words keyed correctly.

Research question #11. Overall, pretest-posttest results indicated that DNLs did statistically significantly improve their posttest electronically recorded keyboarding

speed scores and did statistically significantly improve their posttest electronically recorded keyboarding accuracy scores following participation in the yearlong one-to-one laptop computer classroom program. The null hypothesis was rejected for both keyboarding speed and keyboarding accuracy pretest-posttest comparisons. Scores were determined by completion of a web-based electronically recorded keyboarding skills evaluation in the fall and in the spring. The three-minute test computes speed in words per minute and accuracy by percentage of words keyed correctly.

Research question #12. Overall, posttest-posttest results indicated that while DNLs' posttest electronically recorded keyboarding speed scores were numerically greater, DNLs and DDLs did not perform statistically significantly differently on the keyboarding speed measures and the null hypothesis was not rejected for this comparison. However, DNLs' posttest electronically recorded keyboarding accuracy scores were numerically greater than the DNLs posttest electronically recorded keyboarding accuracy scores and the null hypothesis was rejected for the keyboarding accuracy comparison.

Discussion of Research Questions #1, 2, and 3 Reading Outcomes

Research question #1. While DDLs' pretest-posttest reading vocabulary and reading comprehension scores were not statistically significantly different positive gain over time pretest to posttest was observed for reading vocabulary and reading comprehension mean scores both of which were measured in the average range at posttest.

Research question #2. While DNLs' pretest-posttest reading vocabulary scores were statistically significantly different and their reading comprehension scores were not statistically significantly different, positive gain over time was observed for both reading vocabulary and reading comprehension mean scores both of which were measured in the average range at posttest.

Research question #3. While posttest-posttest results indicated that DNLs' posttest reading vocabulary and reading comprehension mean scores were numerically greater than DDLs', DNLs and DDLs did not perform statistically significantly differently on the reading norm-referenced achievement measures. The null hypothesis was not rejected for the reading vocabulary and the reading comprehension posttest-posttest comparisons.

The yearlong one-to-one laptop computer classroom program resulted in pretest-posttest reading vocabulary and reading comprehension test score gain although statistically significantly different only for the DNLs' reading vocabulary pretest-posttest comparison. Because both groups test scores were measured within the average range at posttest with test score gain observed in reading vocabulary and reading comprehension over time the impact of the yearlong one-to-one laptop computer classroom program result should be considered to be positive and equivalent for both groups of students, digital divide learners and digital native learners.

Reading achievement gain was seen within both DDLs and DNLs, but significant gain was seen only in the DNLs' reading vocabulary scores. This supports findings that students who have and use home computers have better overall academic achievement performance (Borzekowski & Robinson, 2005). However, Johnson (2000) found that computers might have little effect on reading skills. The achievement implications for this study demonstrate that overall students continue to develop reading vocabulary and reading comprehension skills while using computers in a one-to-one computer laptop classroom. Moreover, not having access to computers and the Internet at home did not impede

reading gain for DDLs. It might, therefore, also be said that new one-to-one computer laptop classroom use did not interfere with students reading vocabulary and reading comprehension progress.

Possibly, a broader based study would be useful, questioning the utility of standardized test scores in determining how the use of technology actually affects student achievement. McNabb, Hawkes, and Rouk (1999) contend "...the tools [used to] measure basic skills don't evaluate how technology supports students in developing capacities to think creatively and critically and vice versa" (p.10). Other questions about the value of standardized testing abound. Students who are accustomed to working with technology may be at a disadvantage taking today's paper-based standardized tests because they are not allowed to use the computers and keyboards when being tested (Russell, O'Dwyer, Bebell, & Tucker-Seeley, 2004). The literature seems to suggest that if we are to accurately determine the impact of continual technology use in the classroom than new measures, which include the computer in the assessment process will have to be developed. The high stakes bubble-sheet assessments and digital computer-based preparation disconnect remains problematic. In fact, in one study only 30% of students who

regularly wrote on computers tested at a passing level when they were forced to use paper and pencil, while 67% tested at a passing level when they used a computer for the test (Russell & Haney, 1997). This might be so misleading that it under-estimates student achievement severely for those students who are comfortable working with computers (Russell & Higgins, 2003).

Discussion of Research Questions #4, 5, and 6 Writing Outcomes

Research question #4. The DDLs' posttest writing mean score of 4.40 is congruent with Progressing level writing performance. DDLs' pretest-posttest writing score comparison was not statistically significantly different, however, slight positive gain was observed over time.

Research question #5. The DNLs' posttest writing mean score of 4.60 is congruent with progressing level writing performance. DNLs' pretest-posttest writing score comparison was not statistically significantly different, however, slight positive gain was observed over time.

Research question #6. The null hypothesis was not rejected for the DDLs' and DNLs' writing posttest-posttest comparison.

The yearlong one-to-one laptop computer classroom program resulted in pretest-posttest writing test score

gain although statistically significant differences were not found in either DDLs or DNLs writing pretest-posttest comparisons. Because both groups' writing test scores were measured within the Progressing range at posttest with slight positive test score gain observed over time the impact of the yearlong one-to-one laptop computer classroom program result should be considered to be positive and equivalent for both groups of students, DDLs and DNLs.

When computers are used for editing and re-writing, writing achievement scores improve (Bebell, O'Dwyer, Russell, & Seeley, 2004). Although technology has been used for years to teach writing, the evidence is mostly anecdotal, with small sample numbers and little control over other variables in most cases (Burner, 2008). The same study suggests the difference between success and failure in a technology-infused classroom is largely dependent upon the teacher's approach, comfort level, and understanding of technology. Teachers with a clear understanding of the best practices of technology and educational pedagogy, with a supportive school environment, are strong positive indicators of the impact technology can have on curriculum integration (Grant, Ross, Wang, & Potter, 2005). Unprepared or reluctant teachers will not likely successfully integrate technology and curriculum (Christensen, 2002).

It is possible that a danger may exist in overusing computers, possibly as a substitute for more effective forms of instruction (Fuchs & Wößmann, 2005). Technology is a modern tool that has entered the lives of virtually everyone, and in our schools the attempts to segregate the effects of computers and technology as unique independent variables separate from achievement "...may be both difficult and unproductive" (PCAST Panel on Educational Technology, 1997; p. 93-94). Technology offers a variety of ways to connect and communicate with students and help them achieve, however much work remains before teachers will know the extent of this promise.

Discussion of Research Questions #7, 8, and 9 Technology Outcomes

Research question #7. DDLs' pretest-posttest total technology skills domain scores comparison was statistically significantly different, with positive gain and a change of technology score nomenclature from pretest progressing to posttest proficient. The DDLs' posttest total technology skills domain scores mean of 9.40 is congruent with a proficient level of technology performance.

Research question #8. DNLs' pretest-posttest total technology skills score comparison was statistically

significantly different, with positive gain and a change of technology score nomenclature from pretest progressing to posttest proficient. The DNLs' posttest total technology skills score mean of 9.87 is congruent with a proficient level of technology performance.

Research question #9. Overall, posttest-posttest results indicated that while DNLs' posttest total technology skills domain scores were numerically greater, DNLs and DDLs did not perform statistically significantly differently on the technology skills measures. The null hypothesis was not rejected for the total technology skills domain scores comparisons.

Computer skills are necessary for workers in the modern day workplace. Computer users earn higher wages than non-users according to an empirical analysis (Borghans, L., & Ter Weel, B., 2008). As the Partnership for 21st Century Skills notes, "The world in which we live is increasingly sophisticated, multifaceted, and nuanced. People need high-level learning skills to act, respond, learn, and adjust to ever-changing circumstances. As the world grows increasingly complex, success and prosperity will be linked to people's ability to think, act, adapt, and communicate creatively" (2003, p. 10).

Both DDLs and DNLs improved their technology skills

domain scores equally, and in the posttest-posttest comparison (9.40 and 9.87, respectively) no statistical difference was observed. These scores fell within the proficient level of technology performance. Information and technology affect virtually every person in every setting, including business, public service, and education. In a society based on information literacy the vital skills set consisting of locating, utilizing, and evaluating information to provide solutions has become fundamental in all walks of life (Eisenberg, 2008). In the changing world students may be developing new technology skills and competencies which are not being measured by traditional means (Fisher, Dwyer, & Yocam, 1996). Early one-to-one laptop computer instruction and use puts these information resources into everyday learning activities of young children not as a separate practice but rather as one integrated process. We cannot afford to have a society of *digital have-nots*.

Discussion of Research Questions #10, 11, and 12

Keyboarding Outcomes

Research question #10. Pretest-posttest results indicated that DDLs did statistically significantly improve their posttest electronically recorded keyboarding speed scores and did statistically significantly improve their

posttest electronically recorded keyboarding accuracy scores following participation in the yearlong one-to-one laptop computer classroom program. The null hypothesis was rejected for both keyboarding speed and keyboarding accuracy pretest-posttest comparisons.

Research question #11. Overall, pretest-posttest results indicated that DNLs did statistically significantly improve their posttest electronically recorded keyboarding speed scores and did statistically significantly improve their posttest electronically recorded keyboarding accuracy scores. The null hypothesis was rejected for both keyboarding speed and keyboarding accuracy pretest-posttest comparisons.

Research Question #12. Posttest-posttest results indicated that while DNLs' posttest electronically recorded keyboarding speed scores were numerically greater, DNLs and DDLs did not perform statistically significantly differently on the keyboarding speed measures and the null hypothesis was not rejected for this comparison. However, DNLs' posttest electronically recorded keyboarding accuracy scores were numerically greater than the DDLs' posttest electronically recorded keyboarding accuracy scores and the null hypothesis was rejected for the keyboarding accuracy comparison. It seems that DNLs may have brought a greater

practice effect into their one-to-one laptop computer program resulting in keyboarding accuracy while DDLs may have been focused on acquiring keyboarding speed even during accuracy activities and assessments.

Daily access and use of laptop computers in this study resulted in significant increases in technology skills for both groups, DDLs and DNLs. The same is true for keyboarding skills. DDLs and DNLs significantly improved keyboarding skills as measured pretest to posttest in both speed and accuracy. But posttest-posttest comparisons found no significant difference in keyboarding speed, while there was a significant difference in keyboarding accuracy. DNLs' higher keyboarding accuracy scores may be due to access to the technology at home, while DDLs were being introduced to the keyboarding skills for the first time. Keying in text on a computer keyboard is a skill that can have a large impact on essay scores, organization of narrative, length of sentences, and so on, and those who are sufficiently skilled can concentrate on content (Wolfe & Manalo, 2004).

Implications for Further Research

Suggestions for further research include increasing the duration of the study beyond one school year. Three or more years would provide additional in-depth data. Typically, by the third year teachers modify the use of

laptops to fit their own needs and those of their students, but in the first year little change occurs (Morrison, Ross, & Lowther, 2006). Furthermore, the small sample size consisted of 25 participants; a greater number of participants would support greater utility and generalizability of results. Inclusion of other grade levels, especially the intermediate and middle school grades would certainly expand the scope of future studies. Of greater concern is what are the far-reaching effects on students without computers and modern technology at home who also do not have access to computers at school. This study suggests DDLs are able to achieve equally with their more economically advantaged--or at least computer advantaged--peers.

A closer look at the effect of laptop computers used in both the classroom and at home to complete specific writing homework assignments, to complete specific Internet information research homework assignments, and to study the effect of communication tools like e-mail, blogs, wikis, and other socio-cultural learning is warranted.

It would be of interest to conduct a mixed-methods study including teacher and student interviews, surveys, and observations for qualitative analysis. Though not part of this study, teachers and students did evaluate the one-

to-one laptop classroom program and their informal consensus as reported to this researcher was extremely positive. Anecdotal findings may be under utilized with more credence due the qualitative aspect. Noticeable trends may emerge that cannot be delivered by quantitative methods alone (Field, 2007).

The laptop computers used in this study were not allowed to travel home with the students, which limited the study's scope. Had this been allowed, other views would have been possible including the impact of parents upon students' laptop computer use, understanding, and achievement, as well as the impact upon the parents, themselves. For families of poverty the opportunity may have offered some real benefits.

A well-planned long-term study comparing students in schools with one-to-one laptop computer classrooms to schools without one-to-one laptop computer classrooms in similar neighborhoods, populations, and economic conditions would be relevant. Ubiquitous laptop programs in schools must provide careful attention to planning, training, professional development, hardware and software, change management, monitoring, and evaluation (Bonifaz & Zucker, 2004).

This study showed that overall, students who did not have access to computers at home advanced at a rate that eliminated statistical differences in posttest-posttest achievement and technology skills comparisons. The hoped for outcome of extensive computer use particularly for digital divide learners may just be that as they advance in their computer learning, work will turn to joyful learning and exploratory worldwide access wonderment. Finally, as an ideal, all students must become digital native learners and this must begin in our classrooms.

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Appendix A. Teacher-evaluated *Student Technology*

Skills Domain Rubric

One-to-One Laptop Pilot
Student Computer/Technology Application Rubric

Student's Name: _____ Teacher's Name _____
 Observation Date(s): _____

	Points				Score
	0	1	2	3	
1. Basic Computer (laptop) and Technology Use	Student does not use the laptop or technology.	Student uses the laptop and technology only when necessary.	Student can use the scroll pad, open and close programs, and save, retrieve, and print documents.	Student uses technology regularly for school and personal reasons.	—
2. Application and Internet Use	Student cannot open up applications without help, and does not use the Internet.	Student can open applications with prompts and do basic Internet searches.	Student can open applications, creates and saves work and incorporates information from the Internet.	Student incorporates laptops and technology throughout the curriculum and regularly completes computer-based projects.	—
3. Comfort Level/Attitude about Using Technology	Student does not feel comfortable using technology.	Student occasionally uses the Internet and other digital resources to look for information.	Student is comfortable using technology for research and web browsing.	Student shares ideas with others and uses various technology tools and software in the classroom.	—
4. Communication	Student is not effective in using laptop and e-mail for communication.	Student occasionally uses e-mail to communicate with teachers and students.	Student uses e-mail to retrieve files, send in assignments, and ask questions.	Student uses e-mail frequently to retrieve and share files, and edit digital work with the teacher.	—
5. Word Processing	Student does not have basic keyboarding skills.	Student has basic keyboarding skills, but must look at keyboard when typing.	Student has basic keyboarding skills and can complete written assignments digitally.	Student can write, edit, and print paragraphs and assignments.	—
				Total Points →	—

Teacher's Comments: _____

Appendix B. School District Study Approval Letter

OMAHPUBLIC
SCHOOLS**DIVISION OF RESEARCH**

3215 CUMING STREET, OMAHA, NEBRASKA 68131-2024, 402)557-2080 FAX: (402)557-2049

April 4, 2008

Re: "Growing Up Without Computers: Achievement Outcomes of 4th Grade Digital Divide Students Participating in Laptop Computer Classrooms"

Dear: Dan Bird

The Research Review Committee has reviewed your research proposal that involves the collection of data from students, teachers, and administrators through processes such as the examination and/or collection of information from files or records, direct observation, focus groups, or individual interviews.

We believe your study has merit and permission is granted for you to proceed under the following conditions:

- The Principal of Belvedere School agrees to your study.
- Teachers in affected buildings agree to your study.
- In the reporting of the data, neither students nor schools will be personally identifiable.
- You will be willing to share results of your study with OPS.

Thank you for your interest and support in meeting the needs of our students.

Best wishes.

Sincerely,



Deann Goeser
Instructional Research Administrator

DG/jt