The Pennsylvania State University
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THE EFFECT OF THE AVAILABILITY OF TECHNOLOGY ON TEACHERS' USE OF TECHNOLOGY AND STUDENT ACHIEVEMENT ON STANDARDIZED TESTS

A Thesis in

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ABSTRACT

Educators and policymakers expect to improve student learning by integrating technology in schools and classrooms. It is difficult to measure a direct causal link between the number of computers or Internet connections and student achievement, because computer technologies influence achievement on many levels and many other factors are also involved in producing student achievement. However, we can examine how technology fulfills educators' and policymakers' expectations with regard to standardized tests.

This is a study of four relationships: (1) between the availability of computers and Internet connections in a school and students' standardized test scores; (2) between the availability of computers and Internet connections in a school and the percentage of low-income children in a school and students' standardized test scores; (3) between the number of computers and Internet connections in a school and the ways teachers are using the technologies available (as reported by school principals and classified according to Bloom's Taxonomy); and (4) between how teachers use the available technology (as reported by school principals according to Bloom's Taxonomy) and students' standardized test scores.

The purpose of this study was to investigate the effects of the availability of technology on teachers' use of technologies and student achievement as measured by standardized tests. Teachers' use of technologies was defined as how much time teachers assigned students to use technologies for higher-order skill development and basic skill development. Student achievement was defined as the school's results on the

Pennsylvania System of School Assessment (PSSA), which included 5^{th} grade reading mean scores in 2001, 5^{th} grade reading mean gain scores from 2000 to 2001, 5^{th} grade math mean scores in 2001, and 5^{th} grade math mean score gains from 2000 to 2001. This study also investigated the extent to which the effects of the availability of technology on student achievement might be attributed to a school's socio-economic status (SES), using the percentage of low-income children in a school as an indicator of SES.

Results indicated that: (1) while controlling SES, neither the ratio of students per computer nor the ratio of students per Internet connection had a significant effect on student achievement. However, when SES was used as a factor, effects were found, primarily for schools with many low-income students; (2) on the reading and the math tests, among schools with a high percentage of low-income children (Low SES), students in schools with either a high or a middle ratio of computers per student performed significantly better than those in schools with a low computer/student ratio; (3) on the math test, among schools with the middle percentage of low-income children (Middle SES), students in schools with a high computer/student ratio performed significantly better than those in schools with a low computer/student ratio; (4) on the reading test, among schools with a high percentage of low-income children (Low SES), students in schools with a high Internet connection/student ratio performed significantly better than students in schools with a low Internet connection/student ratio; (5) on the math test, among schools with a high percentage of low-income children (Low SES), students in schools with a high Internet connection/student ratio performed significantly better than students in schools with either a middle or a low Internet connection/student ratio.

Results of a survey of school principals about technology use among their fifth grade teachers also indicated that teachers are more likely to assign students to use technologies to develop both higher-order skills and basic skills when they have many computers and Internet connections.

Implications for educators and future research are discussed.

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CHAPTER 1

INTRODUCTION

This is a study of four relationships:

1) The relationship between the availability of computers and Internet connections in a school and students' standardized test scores;
2) The relationship between the availability of computers and Internet connections in a school and the percentage of low-income children in a school on students' standardized test scores;
3) The relationship between the number of computers and Internet connections in a school and the ways teachers are using the technologies available (as reported by school principals and classified according to Bloom's Taxonomy); and
4) The relationship between how teachers use the available technology (as reported by school principals according to Bloom's Taxonomy) and students' standardized test scores.

Educators and policymakers expect to improve student learning by integrating technology in schools and classrooms. It is difficult to measure a direct causal link between the number of computers or Internet connections and student achievement, because computer technologies influence achievement on many levels and many other factors are also involved in producing student achievement. However, we can examine how technology fulfills educators and policymakers' expectation with regard to standardized tests.

Roblyer, Edwards, and Havriluk (1997) offered a rationale for using technology in education, identifying four primary reasons:

1. Motivation
2. Unique instructional capabilities
3. Support for new instructional approaches, and
4. Increased teacher productivity.

Motivating students to learn is a compelling reason for using technology in education. Teachers know that if their students are interested in what they are doing, they will devote more time and energy, and will gain more from the experience. The technology has the ability to facilitate unique learning environments, which couldn't be seen in the traditional classrooms. Also, technology supports new instructional approaches, such as cooperative learning, shared intelligence, problem-solving and higher-order skills. Finally, technology increases teacher productivity, for example, providing more resources, reducing workload, and helping teachers spend more time with students.

This study investigates technology's ability to support new instructional approaches, and how this technology contributes to students' academic achievement.

The Statement of the Problem

In 1997, the President's Committee of Advisors on Science and Technology (PCAST)), Panel on Educational Technology reported that computing and networking technologies have the potential to transform K-12 educational systems in important ways, and stated justification for the immediate and widespread incorporation of such technologies within all of American elementary and secondary schools (President's Committee of Advisors on Science and Technology, 1997).

American schools are purchasing hardware at a relatively rapid rate. During the 1995 – 96 school year, public elementary and secondary schools in the United States spent between $3.5 and $4.5 billion on educational technology, including hardware, wiring, infrastructural enhancements, software and digital information resources, systems support, and technology-related professional development (President's Committee of Advisors on Science and Technology, 1997). Also, the First Annual State-of-the-States in Educational Technology Survey reported that 65% of the 31 states reported expecting to spend as much or more on the purchase of new hardware in 2002 than they spent in 2001 ("The First Annual State-of-the-States Survey", 2002).

The ratio of computers per student has increased from one computer to every 125 students in 1983 to one computer to every 6 students in 1999, and 4.9 students in 2001 (Williams, 2001). By 2000, 94% of public schools were connected to the Internet, an increase from 35% in 1994 (Williams, 2001). In 1994, only 3% of all public school "instructional classrooms" were connected to the Internet, but in 2000 that percentage had increased to 69%. This means that in 69% of U.S. classrooms, teachers could be using the Internet for instructional purposes (Williams, 2001).

Despite the increases in the number of computers and connections to the Internet, it is questionable whether these technological improvements in terms of quantity have led to improvements in students' academic achievement. The results of the 2000 National Assessment of Educational Progress have been released for both 4th and 8th grade mathematics, reading, and science ("The National Assessment of Educational Progress: Design 2000-2010", 1999). Forty-one states and the District of Columbia participated in the assessment. Since the last administration of the state level NAEP tests in math in 1996, 17 states have made statistically significant gains in the percentage of students scoring at or above the "proficient" level, with nine states making improvements in math in both the 4th and 8th grades. However, the reading and writing assessments were last given in 1998, and more than half of 4th and 8th graders fail to reach the most minimal standard on national tests in reading and math ("Quality Counts '98", 1998).

We all know that just using technology is not going to impact every student's learning. When technology is used in certain ways, research shows that technology integration can improve student achievement (ACOT, 1998; Wenglinsky, 1998). However, if there are many students per computer, and few or poor Internet connections, it can be difficult to engage students in either higher-order thinking or drill and practice to improve student learning. Too few computers and poor Internet connections will prevent students accessing learning opportunities online.

The link between the number of computers or the Internet and student achievement is difficult to measure. The percentage of low-income children is one of the factors that influence student achievement (Wenglinsky, 1998; Branigan, 2000). Therefore, the percentage of low-income children in a school, as an indicator of school SES, is used in this study as a factor to determine the influences of both SES and technology availability on student achievement. The current study is also designed to investigate whether the amount of technology influences teachers' use of technology, and whether their use of technology influences student achievement.

Purpose of the Study

The Presidential Committee of Advisors on Science and Technology (PCAST) recently reported that:

> "Most researchers and practitioners in the field of educational technology are already convinced that information technologies have the potential not only to improve the efficacy of our current teaching methods, but perhaps more importantly, to support fundamental changes in those methods that could have important implications for the next generation."

But are technologies making a difference? Does more technology mean more academic improvement? Given that there has been insufficient research that confirms the committee's statement, the primary purpose of this study is to investigate the relationship between the availability of technology resources in schools and improvements in the students' standardized test scores. In order to achieve this goal, the study will first investigate the relationship between the availability of technology resources, and students' standardized test scores, focusing on the number of computers and the number of computers with Internet connections. Further, since factoring out the effects of school SES is feasible, this study will investigate the relationship between the amount of technology and the percentage of low-income children in a school (school SES) on student achievement. Then, the relationship between the availability of technology resources and the amount of time teachers use technology in their classrooms will be investigated, as will the relationship between the ways in which the technologies were used and student achievement.

Research Questions

As a way to attain the goal of this study, the following research questions and hypotheses are addressed:

1. Is there a relationship between the ratio of computers per student in a school and student achievement?
    - 1.1. Is there a relationship between the ratio of computers per student in a school and 5th graders' reading scores in the most recent year?
    - 1.2. Is there a relationship between the ratio of computers per student in a school and the change in 5th graders' reading scores from the previous year to the most recent?
    - 1.3. Is there a relationship between the ratio of computers per student in a school and 5th graders' math scores in the most recent year?
    - 1.4. Is there a relationship between the ratio of computers per student in a school and the change in 5th graders' math scores from the previous year to the most recent?
2. Is there a relationship between the ratio of computers with Internet connection per student and student achievement?
    - 2.1. Is there a relationship between the ratio of computers with Internet connection per student in a school and 5th graders' reading scores in the most recent year?

2.2. Is there a relationship between the ratio of computers with Internet connection per student in a school and the change in 5th graders' reading scores from the previous year to the most recent?

2.3. Is there a relationship between the ratio of computers with Internet connection per student in a school and 5th graders' math scores in the most recent year?

2.4. Is there a relationship between the ratio of computers with Internet connection per student in a school and the change in 5th graders' math scores from the previous year to the most recent?

3. Is there a relationship between the ratio of computers per student in a school and the school SES on student achievement?

   3.1. Is there a relationship between the ratio of computers per student in a school and the school SES on 5th graders' reading scores in the most recent year?

   3.2. Is there a relationship between the ratio of computers per student in a school and the school SES on the change in 5th graders' reading scores from the previous year to the most recent?

   3.3. Is there a relationship between the ratio of computers per student in a school and the school SES on 5th graders' math scores in the most recent year?

   3.4. Is there a relationship between the ratio of computers per student in a school and the school SES on the change in 5th graders' math scores from the previous year to the most recent?

4. Is there a relationship between the ratio of computers with Internet connection per student in a school and the school SES on student achievement?

4.1. Is there a relationship between the ratio of computers with Internet connection per student in a school and the school SES on 5th graders' reading scores in the most recent year?

4.2. Is there a relationship between the ratio of computers with Internet connection per student in a school and the school SES on the change in 5th graders' reading scores from the previous year to the most recent?

4.3. Is there a relationship between the ratio of computers with Internet connection per student in a school and the school SES on 5th graders' math scores in the most recent year?

4.4. Is there a relationship between the ratio of computers with Internet connection per student in a school and the school SES on the change in 5th graders' math scores from the previous year to the most recent?

5. Is there a relationship between either the ratio of computers per student or computers with Internet connection per student and how teachers in the school use these technologies with their students, when teachers' use of technology is classified according to time spent in "higher-order" and "basic skills," based on the Principal's assessment of technology use according to Bloom's Taxonomy?

5.1. Is there a relationship between either the ratio of computers per student or Internet connections per student and how much time teachers in the school use these technologies with their students for higher-order skills?

5.2. Is there a relationship between either the ratio of computers per student or Internet connections per student and how much time teachers in the school use these technologies with their students for basic skills?

6. Is there a relationship between how teachers use technologies (when teachers' use of technology with their students is classified according to time spent in "higher-order" and "basic skills," based on the Principal's assessment of technology use according to Bloom's Taxonomy) and achievement test scores?

   6.1. Is there a relationship between how much time teachers use technologies with their students for higher-order skills and 5th graders' reading scores in the most recent year?

   6.2. Is there a relationship between how much time teachers use technologies with their students for higher-order skills and the change in 5th graders' reading scores from the previous year to the most recent?

   6.3. Is there a relationship between how much time teachers use technologies with their students for higher-order skills and 5th graders' math scores in the most recent year?

   6.4. Is there a relationship between how much time teachers use technologies with their students for higher-order skills and the change in 5th graders' math scores from the previous year to the most recent?

   6.5. Is there a relationship between how much time teachers use technologies with their students for basic skills and 5th graders' reading scores in the most recent year?

6.6. Is there a relationship between how much time teachers use technologies with their students for basic skills and the change in 5th graders' reading scores from the previous year to the most recent?

6.7. Is there a relationship between how much time teachers use technologies with their students for basic skills and 5th graders' math scores in the most recent year?

6.8. Is there a relationship between how much time teachers use technologies with their students for basic skills and the change in 5th graders' math scores from the previous year to the most recent?

6.9. Is there a relationship between how much time teachers use technologies with their students for higher-order skills in reading and 5th graders' reading scores in the most recent year?

6.10. Is there a relationship between how much time teachers use technologies with their students for higher-order skills in reading class and the change in 5th graders' reading scores from the previous year to the most recent?

6.11. Is there a relationship between how much time teachers use technologies with their students for higher-order skills in math class and 5th graders' reading scores in the most recent year?

6.12. Is there a relationship between how much time teachers use technologies with their students for higher-order skills in math class and the change in 5th graders' math scores from the previous year to the most recent?

6.13. Is there a relationship between how much time teachers use technologies with their students for basic skills in reading class and 5th graders' reading scores in the most recent year?

6.14. Is there a relationship between how much time teachers use technologies with their students for basic skills in reading class and the change in 5th graders' reading scores from the previous year to the most recent?

6.15. Is there a relationship between how much time teachers use technologies with their students for basic skills in math class and 5th graders' math scores in the most recent year?

6.16. Is there a relationship between how much time teachers use technologies with their students for basic skills in math class and the change in 5th graders' math scores from the previous year to the most recent?

To answer research questions 1 - 4, existing data, which was collected by the Pennsylvania Department of Education, but not previously used to address these questions, will be used. Then, these data will be combined with data from survey research conducted by the researcher to explore Questions 5 and 6.

Hypotheses

The following hypotheses will be tested. Basically, the researcher expects that there will be relationships between variables. However, no relationships between independent variables and dependent variables are predicted since few studies exist regarding the relationships between these variables.

Hypothesis 1. There is no relationship between the ratio of computers per student in a school and 5th graders' (1) reading scores in the most recent year, (2) reading gain scores from the previous year to the most recent, (3) math scores in the most recent year, and (4) math gain scores from the previous year to the most recent.

Hypothesis 2. There is no relationship between the ratio of computers with Internet connection per student and 5th graders' (1) reading scores in the most recent year, (2) reading gain scores from the previous year to the most recent, (3) math scores in the most recent year, and (4) math gain scores from the previous year to the most recent.

Hypothesis 3. There is no relationship between the ratio of computers per student in a school and the school SES on 5th graders' (1) reading scores in the most recent year, (2) reading gain scores from the previous year to the most recent, (3) math scores in the most recent year, and (4) math gain scores from the previous year to the most recent.

Hypothesis 4. There is no relationship between the ratio of computers with Internet connection per student and the school SES on the 5th graders' (1) reading scores in the most recent year, (2) reading gain scores from the previous year to the most recent, (3) math scores in the most recent year, and (4) math gain scores from the previous year to the most recent.

Hypothesis 5. There is no relationship between either the ratio of computers per student or computers with Internet connection per student and how teachers in the school use these technologies with their students, when teachers' use of technology is classified according to time spent in "higher-order" and "basic skills," based on the Principal's assessment of technology use according to Bloom's Taxonomy.

Hypothesis 5-1. There is no relationship between either the ratio of computers per student or Internet connections per student and how much time teachers in the school use these technologies with their students for higher-order skills.

Hypothesis 5-2. There is no relationship between either the ratio of computers per student or Internet connections per student and how much time teachers in the school use these technologies with their students for basic skills.

Hypothesis 6. There is no significant relationship between how teachers use technologies with their students (when teachers' use of technology is classified according to time spent in "higher-order" and "basic skills," based on the Principal's assessment of technology use according to Bloom's Taxonomy) and student achievement.

Hypotheses 6 -1 ~ 6-4 There is no significant relationship between how much time teachers use of technologies with their students for higher-order skills and (6-1) 5th graders' reading scores in the most recent year, (6-*2*) reading gain scores from the previous year to the most recent, (6-*3*) math scores in the most recent year, and (6-4) math gain scores from the previous year to the most recent.

Hypotheses 6-5 ~ 6-8 There is no significant relationship between how much time teachers use of technologies with their students for basic skills and (6-5) 5th graders' reading scores in most recent year, (6-6) reading gain scores from the previous year to the most recent, and (6-7) math scores in the most recent year, and (6-8) math gain scores from the previous year to the most recent.

Hypotheses 6 -9 ~ 6-10 There is no significant relationship between how much time teachers use technologies with their students for higher-order skills in reading class and (6-9) 5th graders' reading scores in the most recent year, and (6-10) reading gain scores from the previous year to the most recent.

Hypotheses 6 -11 ~ 6-12 There is no significant relationship between how much time teachers use technologies with their students for higher-order skills in math class and (6-11) 5th graders' math scores in the most recent year, and (6-12) math gain scores from the previous year to the most recent.

Hypotheses 6 -13 ~6-14 There is no significant relationship between how much time teachers use technologies with their students for basic skills in reading class and (6-13) 5th graders' reading scores in the most recent year, and (6-14) reading gain scores from the previous year to the most recent.

Hypotheses 6 -15 ~ 6-16 There is no significant relationship between how much time teachers use technologies with their students for basic skills in math class and (6-15) 5th graders' math scores in the most recent year, (6-16) math scores from the previous year to the most recent.

Definitions

Independent Variables

The Ratio of Computers per Student (C/S): To determine this ratio, a student to computer ratio was first calculated. To do this, the student total enrollment was divided by the number of computers in the school. The ratio was converted to categorical variable by classifying the bottom of 1/3 as low, the middle 1/3 as middle, and the top 1/3 as high. The average of the ratio of students per computer is 5.6 (N = 1376, SD = 3.1164). The range is from .6 to 36.6.

These ratios were then reclassified to create a "computer to student" ratio classification for each school.

- A high computer/student ratio (HC/S) means that the school has many computers compared to the number of students.
- A middle computer/student ratio (MC/S) means that the school's ratio of computers per student was neither low nor high.
- A low computer/student (LC/S) means that the school has few computers compared to the number of students.

The Ratio of Computers with Internet Connection per Student (I/S): To determine this ratio, a student to Internet connection ratio was first calculated. To do this, the student total enrollment was divided by the number of Internet connections in the school. The ratio was converted to categorical variable by classifying the bottom of 1/3 as low, the middle of 1/3 as middle, and the top of 1/3 as high. The average of the ratio of students per computer with Internet access is 18.1 (N = 1344, SD = 48.8625). The range is from .6 to 715.0.

These ratios were then reclassified to create an "Internet connection to student" ratio classification for each school.

- A high Internet connection/student ratio (HI/S) means that the school has many Internet connections compared to the number of students.

- A middle Internet connection/student ratio (MI/S) means that the school's ratio was neither low nor high.
- A low Internet connection/student ratio (LI/S) means that the school has few Internet connections compared to the number of students.

SES (The percentage of low income children in a school): The percentage of children in the school who qualified for free or reduced price lunches based on family income level was used as the indicator for school SES. Three levels of SES characterize schools with the fewest poor students as low and the schools with the most poor student as high. The average percentage of low-income children in schools is 33.30% (N = 1380, SD = 24.0677). The range is from 0% to 100%.

- A high SES: 0 – 18.70% of low-income children in a school. This means that the school has relatively few low-income children.
- A middle SES: 18.80 % - 40.10 % of low-income children in a school. This means that the school has typical number of low-income children.
- A low SES: 40.20 % - 100 % of low-income children in a school. This means that the school has many low-income children.

The Availability of Computers and Internet Connections (C/C + I/S): Schools were categorized into three groups based on the ratio of computers per student and three groups based on the ratio of computers with Internet connection per student. These were then combined by identifying schools that were high in both ratios, high in one ratio and low in another, or low in both.

Teacher's Use of Technology for Higher-order Skills (High): The total minutes that principals reported that 5th grade teachers use technology for higher-order skills were categorized, with the bottom 1/3 classified as low and the top 1/3 identified as high. (The middle group will not be considered during data analysis.)

- High total minutes that teachers use technology for higher-order skills (HHigh): The range of the high total minutes is between 50 and 1455 minutes per week. The mean use of technology for higher-order skills in the high group is 113.20 minutes per week.
- Low total minutes that teachers use technology for higher-order skills (LHigh): The range of the low total minutes is between 0 and 20 minutes per week. The mean use of technology for higher-order skills in the low group is 33.28 minutes per week.

Teacher's Use of Technology for Basic Skills (Basic): The total minutes that principals reported that 5th grade teachers use technology for basic skills were categorized with the bottom 1/3 identified as low and the top 1/3 designated as high. (The middle group will not be considered during analysis.)

- High total minutes that teachers use technology for basic skills (HBasic): The range of the high total is between 140 and 600 minutes per week. The mean use of technology for basic skills in high group is 244.36 minutes per week.
- Low total minutes that teachers use technology for basic skills (LBasic): The range of the low total is between 0 and 75 minutes per week. The mean use of technology for basic skills in low group is 48.76 minutes per week.

Teacher's Use of Technology for Higher-order Skills in Reading (HR): The total minutes that 5th grade teachers use technology for higher-order skills in reading, from the reading related survey questions (7, 8, and 9) were calculated. These totals were categorized from lowest to highest with the bottom 1/3 classified as low and the top 1/3 designated as high. (The middle group will not be considered during analysis.)

- High total minutes that teachers use technology for higher-order skills in reading (HHR): The range of the high total is between 45 and 1425 minutes per week. The mean minutes that teachers classified as high use technology for higher-order skills in reading is 103.71 minutes per week.
- Low total minutes that teachers use technology for higher-order skills in reading (LHR): The range of the low total is between 0 and 20 minutes per week. The mean minutes that teachers classified as low use technology for higher-orders skills in reading is 10.54 minutes per week.

Teacher's Use of Technology for Higher-order Skills in Math (HM): The total minutes that 5th grade teachers use technology for higher-order skills in math, as reported on the survey question 11, were examined. Since 145 schools reported that no 5th grade teachers use technologies in this way in their math class, the totals were categorized by low and high with the bottom 1/2 identified as low, and the top 1/2 designated as high.

- High total minutes that teachers use technology for higher-order skills in math (HHM): The range of the high total is between 20 and 50 minutes per week. The mean minutes that teachers classified as high use technology for higher-order skills in math is 30.59 minutes per week.

- A low total minutes that teachers use of technology for higher-order skills in math (LHM): The range of the low total is between 5 and 15 minutes per week. The mean minutes that teachers classified as low use technology for higher-orders skills in reading is 8.95 minutes per week.

Teacher's Use of Technology for Basic Skills in Reading (BR) The total minutes that 5th grade teachers use technology for basic skills in reading, as reported on the survey question 1 categorized from lowest to highest with the bottom 1/3 classified as low and the top 1/3 identified as high. (The middle group would not be considered.)

Data sources: Survey- "Technology Use Survey" (Survey question 1)

- High total minutes that teachers use technology for basic skills in reading (HBR): The range of the high total is between 30 and 150 minutes per week. The mean minutes that teachers use technology classified as high for basic skills in reading is 53.89 minutes per week.
- Low total minutes that teachers use technology for basic skills in reading (LBR): The range of the low total is between 15 and 25 minutes per week. The mean minutes that teachers use technology classified as low for basic skills in reading is 17.86 minutes per week.

Teacher's Use of Technology for Basic Skills in Math (BM): The total minutes that 5th grade teachers use technology for basic skills in math were calculated. These totals were categorized from lowest to highest with the bottom 1/3 classified as low, the middle 1/3 designated as middle, and the top 1/3 identified as high. (The middle group would not be considered.)

- High total minutes teachers use technology for basic skills in math (HBM): The range of the high total is between 30 and 150 minutes per week. The mean minutes that teachers use technology classified as high for basic skills in reading is 54.89 minutes per week.
- A low total minutes that teachers use technology for basic skills in math (LBM): The range of the low total is between 15 and 25 minutes per week. The mean minutes that teachers use technology classified as low for basic skills in reading is 17.95 minutes per week.

Covariate

SES: When SES was used as a covariate, the percentage of low-income children in the school was used as the indicator for school SES.

Dependent Variables

- Reading Scores: School result of 5th graders' reading mean scores in 2001.
- Reading Gain Scores: The reading gain score was calculated by subtracting the mean score for 2000 from the mean score for 2001.
- Math Scores: School result of 5th graders' math mean scores in 2001.
- Math Gain Scores: The math gain score was calculated by subtracting the mean score for 2000 from the mean score for 2001.
- Technology use for higher-order skills: The total minutes that principals reported that 5th grade teachers use technology for higher-order skills, as defined above.

- Technology use for basic skills: The total minutes that principals reported that 5th grade teachers use technology for basic skills, as defined above.

The Pennsylvania System of School Assessment

PSSA Results

The annual Pennsylvania System of School Assessment (PSSA) is a standards-based, criterion-referenced assessment used to measure a student's attainment of the academic standards while also determining the degree to which school programs enable students to attain proficiency of the standards. Every Pennsylvania student in 5th, 8th and 11th grade is assessed in reading and math, and students in grades 6, 9 and 11 are assessed in writing. Scores range from 1000 to 1600. The Department of Education has assigned an average score of 1300 in both math and reading for 1995-96. So scores could be compared year-to-year, the average can fluctuate. The average for 1998-99 was 1300 in math and reading for all scores except fifth and eighth-grade reading, for which the average was 1310 (The Pennsylvania Department of Education, 2002). Appendix B provides the PSSA mathematics and reading item section layout.

Technology in Pennsylvania

In Pennsylvania, 69% of schools reported that at least 50% of their teachers use a computer daily for planning and/or teaching in 2000. The national average is 76% schools. John Bailey, the technology director for the Pennsylvania Department of Education, reported that every district had a high-speed connection to the Internet, as did

92% of schools and 70% of classrooms ("State of States", 2001). Also, he addressed that,

> "Some of the best models we have for technology use in education are in rural and poor schools. Schools traditionally thought of as being left in the wake of the technology revolution are leading the revolution in many cases here, and leadership is often the key (p.98). "

Market Data Retrieval reported the recent state of technology in Pennsylvania, in 2000 ("State of States", 2001).

- Students per instructional computer were 4.6, which was little better than the average (4.9) in the U.S.
- Students per Internet-connected computer: 8.8
- Percent of schools with Internet access: 90%
- Percent of schools with Internet access from one or more classroom: 72%
- Percent of schools where the majority of teachers are "beginners" when it comes to using technology: 24%
- Percent of schools where at least 50% of teachers use a computer daily for planning and/or teaching: 69%
- Percent of schools where at least 50% of teachers use the Internet for instruction: 54%
- Percent of schools where at least 50% of teachers have school-based e-mail addresses: 66%

In the next chapter, literature that deals with the availability issue, school SES issue, and the use of technology with regard to student achievement will be reviewed.

CHAPTER 2

LITERATURE REVIEW

In this chapter, literature that issues on restructuring schools with technology will be reviewed, and literature that deals with successful integration of technology in teaching and learning will be reviewed. The availability issue, school SES issue, and the use of technology with regard to student achievement will be also reviewed. Since the number of computers and access to the Internet have grown, the issues of how technologies, especially computers and Internet, appear to be helping students improve their learning will be considered in this chapter.

Restructuring Schools with Technology

An educational reform movement in the U.S. was started in the late 1970s, designed to focus public education on academic content and to introduce higher standards for students and teachers. Since the 1990s, educational reform has focused on fundamental changes in expectations for student learning, in the practice of teaching, and in the organization and management of public schools (Elmore and Associates, 1990).

A three-year study of 55 New York State school districts (Mann & Shafer, 1997) investigated how the investment in technology was affecting student achievement. In this study, teachers said that the more technology was available, the more skillful they were. In this study, most principals strongly agreed that computer-related technology is an important part of school reform. On a scale of 1 to 5, with 1 representing strong disagreement and 5 indicating strong agreement, principals' responses revealed a mean of 4.49 on question that asked if technology was relevant to their school reform efforts. The teachers scored an average of 4.32 on the same question. Also this found that in sixth-grade math tests, there was a strong relationship between increased technology and higher scores on the state's Comprehensive Assessment Report.

Technology is important part in school reform. Educators, policymakers, and administrators are expecting that technology will increase student achievement.

Factors for Successful Technology Integration

Numerous studies have demonstrated that technology has a positive effect on student achievement (Kulik, & Kulik, 1991; McNeil, & Nelson, 1990; Rockman, 1992; Khalili, & Shashoani, 1994). However, it is widely known that technology alone does not produce significant effects on students' learning or teachers' teaching. While some educators may believe that just providing more technology is producing better student achievement, there are several factors that influence the benefits derived from technology in education, such as leadership, staff development, administrative support, availability of technology, availability of technicians, how much time is spent with the technologies, and how the technologies are being used.

SEIR-TEC (Byrom, 1998) reported factors for successful technology integration, following a three-year long research project. This report emphasized that leadership is the key point for successful technology integration. Without support from school districts, transformation of teachers' instructional practices in the schools is almost impossible. Since most decisions regarding school reform are made by administrators, the leadership from the district level and school level regarding learning with technologies in classrooms is important in any school reform effort. As the second factor, reform requires a comprehensive plan, starting with its vision, mission and goals. The third factor stresses the slow progress, generally associated with technology integration. Thus it requires substantial levels of support and encouragement for educators. For the fourth factor, successful technology integration, requires adequate professional development, support, and resources that teachers can use when they integrate technology into their classrooms. Teacher change is the fifth element for successful technology integration. Teachers are the most important factor for integrating new instructional strategy and the technology into teaching and learning. Without teacher change, technology integration will rarely occur. As the sixth factor, the report stresses the need for on-site and on-demand technical assistance with both the technology and the integration of technology into teaching and learning. As the seventh factor, schools should find their own needs for using technology to support teaching and learning. In some schools, as the eighth factor, basic technological equipment and facilities issues are still barriers. And finally, technology integration will happen when educators will benefit from it.

Another study seeking conditions needed for a technologically favorable teaching and learning environments reported that (1) appropriate technology must be available, (2) it will take time and practice to integrate technology into the instructional program, (3) support is needed, and (4) colleagues and administrators need to support innovation (Sheingold and Hadley, 1990; Means and Olson, 1993). When teachers want to integrate technology into their classrooms, they need both technology and support such as technical assistants, professional development programs, and time. And they have to be in instructional contexts that support their innovative teaching practice.

In a survey asking teachers about the barriers to using technology, 82% of teachers mentioned a lack of release time for teachers to learn/participate/plan ways to use computers or the Internet, 78% of teachers pointed out insufficient access to computers, 58% of teachers mentioned that Internet access is not easily accessible, and the lack of administrative support was brought up by 43% (Meyer, 2001). Lack of administrative support was the least significant barrier here, however a lack of administrative support may be responsible for other issues, such as insufficient access to computers, lack of support in integrating telecommunications into the curriculum (68%), inadequate training opportunities (67%), outdated, incompatible, or unreliable computers (66%), and lack of technical support or advice (59%) (Meyer, 2001). For the successful integration of technology into classrooms, requires not only available technology that teachers and students can access, but also administrative support and adequate professional development programs.

A NetDay survey identified how teachers integrated the Internet connections and computers, as well as obstacles to using computers and the Internet ("The Internet, Technology and Teachers", 2001). Teachers reported significant obstacles to using the Internet as an integrated instructional tool and resource. The largest obstacle reported was the lack of sophisticated school leadership on how to best support teachers' efforts when using technology. Less than half of the participating teachers reported lack of equipment, speed of access and lack of technical support as secondary barriers to going online. 32%

of teachers cited lack of leadership from principals or administrators as a deterrent to incorporating the Internet more in their instruction. Among teachers who reported that they were using the Internet, 28% said the pressure for using the Internet came from district administrators, 26% said colleagues and peers and 14% listed students, 10% from principals, and only 2% indicated pressure from parents ("The Internet, Technology and Teachers", 2001). The largest pressure is coming from district administrators. These survey results revealed that district administrators' leadership is critical in encouraging teachers in adopting technology resources in their instruction with technology resources.

In addition to the leadership, professional development for teachers can be another key issue in using technology in classrooms. Teachers are the crucial factor in successful technology integration (Trotter, 1999). Much of a teachers' success in the classroom relies on use of teaching strategies, how they teach, how they communicate, and how they deliver information. McKenzie's (1998) study showed that most staff development efforts failed to address the challenge of transfer. It is asserted that teacher education program should be designed to acquaint the participants with the challenge of transfer and begin equipping them to take what they learned back to their classrooms.

Access to computer-related technologies appears to be required before teachers will learn and use technology in their classrooms. Time is an important factor, because many teachers still have a lot to learn about technology. In a case study, Chung (1997) found that teachers need time to learn how to use technology. Participants were teaching at school, which was highly equipped with computer-related technologies, but they seldom used those tools for instructional purposes, because they didn't have time to learn.

Also, they mentioned that if there were someone who could assist their learning, they would learn technologies and adopt them into their instructions. Administrative support was mentioned as an obvious factor that motivates the teachers to learn about technologies.

In 1996, Union City was recognized by the President for its comprehensive program of educational reform, which had resulted in remarkable improvements in student learning and achievement. The report investigated the impact of state-of-the-art networking technologies in a reformed educational context on students' learning, teachers' teaching, and parental involvement. In their conclusion, the report identified five elements that have been central to Union City's overall success:

1. Leadership and collaboration
2. Strong base of teacher support
3. Teachers at the center of curricular revision and school decision-making
4. Sufficient funding from a variety of sources
5. Attention to public relations.

(Chang, Henriquez, Honey, Light, Moeller, & Ross, 1998).

Successful technology integration cannot be ensured by one factor, many interacting factors influence technology use.

From these conditions found by researchers, we can see that the availability of technology is not enough to ensure successful integration of technology into teaching and learning, but the absence of enough technology is enough to prevent it.

Use of Technology and Student Achievement

Means, Blando, Olson, Middleton, Morocco, Remz, & Zorfass (1993) defined the four major functions of technology:

- As a tutor, such as drill-and-practice software, tutorial programs, instructional television, computer-assisted instruction, and intelligent computer-assisted instruction
- As a means to explore, such as CD-ROM encyclopedias, simulations, hypermedia stacks, network search tools, and microcomputer-based laboratories
- As a tool to create, compose, store, and analyze data using software, such as desktop publishing systems, hypermedia, network search tools, and videotape recording and editing equipment, and
- As a means to communicate with others, such as e-mail, interactive distance learning through satellite systems, computer and modem, and cable links.

In the 1960s, computer-assisted instruction (CAI) was developed to help students acquire basic skills (Kulik, Kulik, and Bangert-Downs, 1991). Since that time, there have been many instructional software programs developed, from drill and practice software programs to problem-solving software designed to help in teaching and learning.

- Drill and practice software allows students to work problems or answer questions and get feedback on correctness.

- Tutorial software acts like tutors by providing all the information and instructional activities that learners need to master a given topic.
- Simulation software models real or imagined systems to show how those systems or similar ones work.
- Instructional games are designed to increase motivation by adding game rules to learning activities.
- Problem-solving software, aimed at directly teaching the steps involved in solving problems, helps learners acquire problem-solving skills by giving them opportunities to solve problems (Roblyer, Edwards, and Havriluk, 1997, p.86).

Each type of instructional software programs has its own function, such as basic skill development or high- level skill development. Teachers should select software carefully, by reviewing its own purpose and integrating it into their teaching.

Besides using instructional software in classrooms, teachers use computer application programs for teaching and learning. Researchers (Becker, Ravitz, and Wong, 1999) found that teachers assign students to use the following instructional software on 3 or more occasions and categorized in the following way:

- Word Processing; finding ideas, expressing in writing
- Presentation software: presenting information to an audience
- Spreadsheet: analyzing information
- Database: analyzing information
- Concept Mapping software: organizing and analyzing information

- Multimedia: presenting information to an audience, analyzing information
- Collaboration tools: sharing ideas
- WWW: communicating electronically, finding ideas

Technology provides various ways of structuring leaning environments in which students can have opportunities never before possible. Of course, teachers should integrate technologies carefully according to their teaching objectives.

The results of a survey conducted by the Center for Applied Special Technology (“Survey: Student Technology Use”, 1999), showed that teachers assigned students to use computers for word processing or creating spreadsheets most frequently (61%), followed by Internet research (51%), practicing drills (50%), solving problems and analyzing data (50%), CD-ROM research (48%), multimedia projects (45%), graphical presentations (43%), demonstration and simulation (39%), and correspondence with experts (23%).

By 1999, 95% of public schools were connected to the Internet, up from 35% in 1994 (Williams, 2001). Up from 35% in 1994, to 63% in 1999, most public school instructional classrooms, computer and other labs, library/media centers, and any other rooms used for instructional purposes, were connected to the Internet. A report (Williams, 2001) revealed its annual survey results describing the current state of technology in U.S. public schools. According to the survey, the use of technology has increased. In 2001, 69% of schools reported that the majority of their teachers use the Internet for instructional purposes, which was an increase from the 63% of schools in 2000. 83% of schools indicated that the majority of their teachers have school-based e-mail addresses in 2001. In 2000, 77% of schools teachers had school-based e-mail addresses. In 2001, 78% of the schools say that the majority of their teachers were using computers on a daily basis for planning and/or teaching, slightly increased compared to 76%, in 2000 (Williams, 2002).

However, Wenglinsky (1998) presented findings from a national study of the relationship between different uses of educational technology and various educational outcomes, administered by the National Assessment of Educational Progress (NAEP) for nearly three decades. For the first time in 1996, NAEP asked students and teachers additional questions about how they used computers in math. After factoring out the influence of several other variables that affect achievement, such as students' socioeconomic status, class size, and teacher qualifications, Wenglinsky (1998) found strong links between certain kinds of technology use, higher scores on NAEP, and an improved school climate. In every case, the gains were greater at the middle school level than in elementary school. The study found that technology had less impact on 4th graders than 8th graders and suggested focusing technology on middle rather than elementary schools (Wenglinsky, 1998). His findings indicated that for eighth-graders,

> "When computers are used to perform certain tasks, namely applying higher order concepts, and when teachers are proficient enough in computer use to direct students toward productive uses more generally, computers do seem to be associated with significant gains in mathematics achievement (p. 32)".

When 8th grade teachers used computers mostly for simulations and application, which were associated with higher-order thinking, their students performed better on NAEP than students whose teachers did not. Also, when 8th grade teachers used computers for drill and practice, which was associated with lower-order thinking, their students performed worse (Wenglinsky, 1998).

However, while findings about positive impacts of technology on student achievement in several research studies, there was a study that found a negative result of technology on student achievement. After randomly interviewing 6,000 U.S. teachers, Market Data Retrieval found that more than 86 percent of the teachers believed Internet use by children in grades 3 to 12 did not improve their academic achievement. (in "Net Day: Questioning The Impact of Computers in the Classroom," 1997).

The dissimilar results from these two studies suggest that technology could help math academic achievement, depending on how it is used and how well teachers are trained to use technology. It implies that when it is properly used technology will have a significant positive impact on teaching and learning. Although technology availability cannot be treated as one single independent variable for successful technology integration, the effort toward technology integration can happen only when technology is accessible. The following section will discuss the relationship between the ratio of students per computer and students per Internet connection and teaching and learning results. Also, poverty issues that relate to student achievement will be discussed.

How much Technology is enough?

Dyrli and Kinnaman (1946b) stressed that school should plan to supply four computers per classroom, network and telecommunications access, CD-ROM and laserdisc players, and display capability for both computers and large screen projection.

However, there are few studies about using technology, in either basic skills development or higher-order skill development, based on the availability of technology in schools or classrooms.

A three-year study of 55 New York State school districts (Mann & Shafer, 1997) investigated how the investment in technology was affecting student achievement. This study, released in 1997, showed good evidence of the effects of educational technology. Based on reports from teachers and principals in high schools to determine the amount of technology available and in use in schools, the study found that 42 percent of the variation in math scores and 12 percent of the variation in English scores was accounted for by the addition of technology in the school. This study also found a strong relationship between increased technology and higher scores in 6^{th} grade math tests on the state's Comprehensive Assessment Report.

The North Central Regional Educational Laboratory (1999) reported the impact of technology on teaching and learning by taking an in-depth look at three distinct phases in technology uses and expectations and addresses whether the use of technology has a positive effect on student learning. The study showed that successful integration of technology depends on having significant critical access to hardware and applications that are appropriate to the learning expectations. Research indicated that one computer for every four to five students is necessary to use technology in a manner to yield significant improvements in learning.

A two-year evaluation of 85 classroom observations, conducted by the Enhancing Missouri's Instructional Networked Teaching Strategies (eMINTS) during 2000 and

2001, showed that the students who participated in the program scored consistently higher in every subject area on the state's standardized tests. The evaluation team members observed teachers' interaction with students, their use of computers, and their general conduct of the lesson. Each eMINTS classroom is equipped with a teacher's desktop computer and laptop computer, a scanner, a color printer, a digital camera, an interactive white board, a digital projector, and one computer for every two students. All computers have basic productivity software and high-speed Internet connections (eMINTS Evaluation Team Policy Brief, 2001).

Wenglinsky's study (1998) found that home computer use is one of the conditions that influence student achievement. However, 73 percent of high educated and high-income households have computers at home, whereas only 14 percent were found to have computer in low income homes or with those who had no more than a high-school education (Tapscott, 2000). Figure 2-1 shows 1 – 6 graders' use of computers at home.

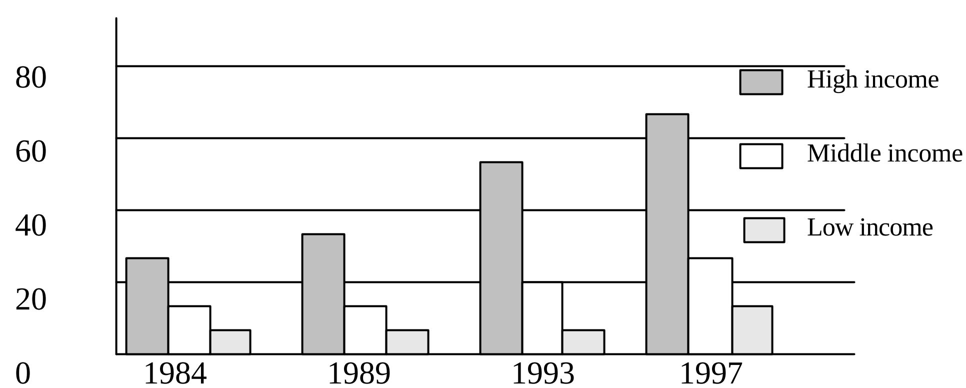


Figure 2-1. Used a Computer at Home – Grade 1 – 6 (Data: U.S. Census Bureau, as cited in Tapscott, 2000). Left column is the percentage of computer use at home.

As Figure 2-1 indicates, few low-income families and their students use a computer at home. High-income families have far better access to computers, and that access is growing, while low-income families are showing not much growth in access to computers.

One study (Branigan, 2000) revealed that poverty, which can limit access to educational technology, was a greatest influence on student achievement among factors, access to educational technology, professional development, and the extent of technology use, in Illinois. The research surveyed 440 elementary, middle, and high school principals twice to measure the scope and implementation of educational technology, also surveyed 718 teachers from the same schools to find out about their use of technology in the classroom. This study investigated factors which might have impact on students' achievement, including on levels of poverty, access to educational technology, professional development, and the extent of technology use, as related to the students' scores from the state's 1998-99 standardized tests. This study indicated that technology use was positively influenced by the amount of access and teacher training a school had.

Also, a National Center for Education Statistics study in 2000 found that 45 percent of teachers in schools that have largely minority students used computers or the Internet for instruction during class, as compared to 56 percent of their colleagues in schools with few minority students (Reid, 2001). These studies exposed that high-poverty schools were making less use of computers and had less access to computers.

One national survey, which was conducted at the Center for Research on Information Technology and Organization in 1999 (Becker, Ravitz, and Wong, 1999), examined how teachers integrated computers into their instructional practices. This survey revealed that computer-using academic secondary teachers who had at least one computer in their classroom for every four students were 3 times more than likely to have students use computers on a regular basis than those who did not have classroom access and used computers in labs instead.

The small number of computers and poor Internet connections will prevent students from access to the computer and the resources afforded by the Internet in either basic or higher-order skill development. Therefore, students' chances to be engaged in learning in a technology-enriched environment will be decreased.

Bloom's Taxonomy

Bloom’s Taxonomy is widely applied in the classroom. Bloom’s Taxonomy is a classification of the goals of the educational process (Bloom, 1956; Nitko, 1983; Reigeluth, 1983). Three domains of educational activities were identified; the cognitive domain, the affective domain, and the psychomotor domain. The cognitive domain of Bloom’s Taxonomy is a division of cognitive objectives into subdivisions ranging from the simplest behavior to the most complex. The other domains are not concerned in this study. The cognitive domain is divided into the following categories:

- Knowledge: remembering of previously learned material.
- Comprehension: the ability to understand the meaning of material.
- Application: the ability to use learned material in new and concrete situations.

- Analysis: the ability to break down material into its component parts so that its organizational structure may be understood.
- Synthesis: the ability to put parts together to form a new whole.
- Evaluation: the ability to judge the value of material for a given purpose.

(Bloom, Engelhart, Furst, Hill, & Krathwhol, 1956; Anderson & Krathwhol, 2001)

In cognitive activities at the knowledge level, a student recalls or recognizes information, ideas, and principles that they were taught. At the comprehension level, the student translates, comprehends, or interprets information based on prior learning. At the analysis level, the student distinguishes, classifies, and relates the assumptions, hypotheses, evidence, or structure of a statement or question. At the synthesis level, the student originates, combines, integrates, or rearranges ideas into a product, plan or proposal. At the evaluation level, the student decides, assesses, or critiques , based on specific standards and criteria.

Among these five levels of learning, knowledge and comprehension are considered as basic skills, since they involve recall or basic understanding. Analysis, synthesis, and evaluation, are considered as higher-order skills, since they require higher-order thinking skills, for example, taking apart, putting together, and judging the outcome. However, the application level is not considered either in basic skills or higher-order skills, because the application level is between basic and higher-order skills.

Use of Technology for Basic Skills

Computer-Assisted instructional programs, such as drill-and-practice, tutorials, and games can help students learn. In the 1970s and 1980s, students mainly used computers for drill and practice (Becker, 1983), on low levels of learning, such as knowledge, and comprehension. The definition of the drill and practice programs "… provide exercises in which students work example items, usually one at a time, and receive feedback on their correctness" (Roblyer, Edward, & Havriluk, 1997, p.86).

Research has shown that children could learn basic skills from computerized drill-and-practice, in mathematics (Trotter, 1998). Drill-and-practice provided students more immediate recall for lower level learning. Students used drill and practice courseware as a way of learning new concepts, correct procedures, and facts (Roblyer, Edwards, & Havriluk, 1997). Students gained "automaticity" through the use of drill-and-practice software, enabling students to learn higher-order skills, which require performing lower-level skill automatically (Bloom, 1986).

A meta-analysis of 40 studies, which compared the effectiveness of traditional instruction alone with a combination of traditional instruction and computer-assisted instruction on students' mathematics achievement, found that the combined traditional-CAI approach was significantly more effective (Burns and Bozeman, 1981). A study that involved implementing computer-assisted instruction with Canadian third and fifth graders found that CAI students were significantly higher than those of students receiving traditional instruction only (Hawley, Fletcher, and Piele, 1986).

Simple, linear tutorial programs are also used for developing basic skills. Students usually learn without any help while using tutorial programs (Roblyer, Edwards, & Havriluk, 1997). Kulik' (1994) meta-analysis study that examined a set of 97 studies that were carried out in elementary school and high schools, found that school program that included tutoring were better, on the average, than results from programs without tutoring. The tutoring programs usually produces positive results in elementary and high school classes (1994). Now, most computer application programs provide tutorials that students can use to learn individually, for example, Microsoft Word, Microsoft Excel, and Microsoft FrontPage, all provide computer-based tutorials. Through well-designed tutorials, students learn computer application programs and they can then use those computer application programs for higher-order learning that might include activities such as, evaluating, analyzing and connecting information by using a database or spreadsheet, elaborating; synthesizing and imaging by using semantic networking tools or expert systems tools; and problem-solving, decision making, or reflecting on their work with peers by using computer mediated communications tools, such as e-mail, bulletin boards, or listserves (Jonassen, 1996).

Kulik (1983) provided the results of a meta-analysis of 48 comparative studies of the effects of computer-based instruction (CBI), and found that CBI was better than traditional methods in promoting achievement. And Kulik's another study (1985), reported the results of three meta-analyses of research on computer-based education (CBE) at the elementary, secondary, and postsecondary levels, found CBE superior to traditional instruction in its effects on achievement, retention, learning rate, and attitudes toward computers and courses., and very positive effects on attitudes toward computers. Kulik and Kulik (1985) presented findings of a meta-analysis of 32 studies of the comparative effects of computer-based instruction (CBI) and non-computer-based instruction. The result showed that computer assisted instruction (CAI) had a significant, positive effect on achievement. Another study of an examination of 199 studies of computer-based instruction at the elementary, secondary, university, and adult education levels, carried by Kulik and Kulik (1987), found that CBI was positive results for student achievement on standardized tests, learning time, attitude toward instruction and toward computers.

Kulik (1994) analyzed a dozen of meta-analysis studies, which carried out to answer questions about the effectiveness of computer-based instruction:

- Students learn more in classes in which they receive computer-based instruction.
- Students learn their lessons in less time with computer-based instruction.
- Students also like their classes more when they receive computer help in them.
- Students develop more positive attitudes toward computers when they receive help from them in school (p.11).

However, all meta-analysis in Kulik's study (1994) showed that computers did not always have positive effects in every area in which they were studied. Also, a study, comparing the mathematics performance of third graders using a commercial computerized drill and practice program with that of similar students using a conventional print drill program, found that there were no statistically significant differences between groups (Campbell, Peck, Horn, and Leigh, 1987). To have productive results with integrating technology, they must be well-developed and well-used.

Use of Technology for Higher-order Skills

Analysis, evaluation, and synthesis in Bloom's Taxonomy represent higher-level learning objectives. Technology can be applied for these learning objectives in promoting critical thinking skills, problem-solving skills, and communication skills, and providing collaborative, active and authentic learning environments. Research shows that students with extensive access to technology learned how to organize complex information, recognize patterns, draw inferences, and communicate findings (Collins, 1991; Barron and Goldman, 1994). By providing learning environments that cause students to engage in higher-order skills such as critical thinking, solving complex problems, and synthesizing different points of view, students performed better.

Studies have also shown that students were more comfortable with critiquing and editing written work when they exchanged their work over a computer network (Margaret, 1989). Additionally, student writing that was shared with other students over a network tends to be of higher quality than writing produced for in-class use only (Margaret, 1989). Other studies showed that high school students with extensive access to technology learn more organization and problem-solving skills than students in more traditional high school programs (Dwyer, 1994). Students showed greater achievement on standardized tests after using computers for math problem solving (Clouse, 1992; Clouse, 1992).

One mathematic software program provides problem-solving and computer programming skills through a story about a planet with a disappearing rain forest (Clements & Wilmot, 1995). With this program, students manipulate geometric shapes to repair damaged bridges, learn map-reading skills to navigate rivers and roads, develop logic skills as they program robots to help them, and use algebra to pack parcels they find along they way.

Since 1992, dealing with important policy areas to be considered in the national plan and technology-related costs of a set of schools making extensive use of technology, the RAND cooperation (Glennan & Melmed, 1996) held a workshop discussing the analysis of costs, and reviews of existing literature to identify key elements of national strategy and federal policy that will contribute to effective use of technology by the nation's schools. RAND concluded that technology could play a key role in school reform as followings:

- Tailor learning experiences more sharply to learner needs and abilities.
- Provide students with access to resources and expertise outside the school, both enriching their learning and extending the time devoted to learning
- Support more authentic assessment of a student's progress
- Assist schools in managing and guiding the learning activities of their students.

When technology can offer a learning environment in which students can actively engage in and think critically about their learning, technology can have impact on teaching and learning. We all know that just using technology is not going to impact every student's learning, but when technology is used in important ways, technology integration can improve students' achievement.

CHAPTER 3

RESEARCH METHOD

Design

This study employed two different methods appropriate to the questions posed above. To address the questions concerning the effects of the number of computers and computers with Internet connection on student achievement, the relationship between the number of computers and Internet connections and a school SES on student achievement, the primary method was secondary research, analyzing the data from the 1,381 Pennsylvania area school data files. The questions concerning the relationship between the availability of computers and Internet access and teachers' use of technology for higher-order and basic skill and how time spent with technology effects student achievement, required the development and analysis of a questionnaire sent to 639 principals, selected from groups identified as "high" technology and "low" technology among 1381 Pennsylvania area schools.

Independent Variables

The independent variables in this study are:

1) The Ratio of Computers per Student (C/S): Low/Middle/High
2) The Ratio of Computers with Internet Connection per Student (I/S): Low/Middle/High

3) SES: The percentage of low-income children in a school (SES): Low/Middle/High

4) The Availability of Computers and Internet Connection (c/s + i/s): Hc/s+Hi/s; Hc/s+Li/s; Lc/s+Li/s.

5) Teachers' Use of Technology for Higher-order Skills (time) (High): Low/High

6) Teachers' Use of Technology for Basic Skills (time) (Basic): Low/High

7) Teachers' Use of Technology for Higher-order Skills in Reading (time) (HR): Low/High

8) Teachers' Use of Technology for Higher-order Skills in Math (time) (HM): Low/High

9) Teachers' Use of Technology for Basic Skills in Reading (time) (BR): Low/High

10) Teachers' Use of Technology for Basic Skills in Math (time) (BM): Low/High

Table 3.1 shows the descriptive statistic in each independent variable.

Table 3.1
Descriptive statistics in each independent variable

Independent Variables		Descriptive Statistics				
		N	Minimum	Maximum	Mean	SD
The ratio of computers per student (C/S)	High Computer (HC/S)	459	.6345	4.1228	3.2169	.6652
	Middle Computer (MC/S)	459	4.1250	5.8421	4.9428	.4982
	Low Computer (LC/S)	458	5.8444	36.6000	8.6874	3.5832
The ratio of Internet connections per student (I/S)	High Internet (HI/S)	448	.6345	5.2973	3.8817	.9211
	Middle Internet (MI/S)	448	5.3000	9.2500	6.8925	1.1340
	Low Internet (LI/S)	448	9.2692	715.0000	43.5713	78.6921
The percentage of low-income children in a school (SES)	High	463	.00	18.70	9.4559	5.1636
	Middle	453	18.80	40.10	28.9336	6.4070
	Low	464	40.20	100.00	61.3713	16.7791
The ratio of computers per student among survey returned schools (c/s)	High Computer (Hc/s)	108	.63	4.12	3.1195	.7549
	Low Computer (Lc/s)	72	5.84	31.46	9.8083	3.9274
The ratio of Internet connections per student among survey returned schools (i/s)	High Internet (Hi/s)	94	.63	5.09	3.4035	.9117
	Low Internet (Li/s)	86	9.30	525.00	44.1464	77.8025
Teachers use of technology for higher-order skill (High)	Low	73	0	20	10.37	8.60
	High	63	50	1455	114.05	178.14
Teachers use of technology for basic skill (Basic)	Low	62	0	75	48.76	20.05
	High	60	140	600	240.43	101.73
Teachers use of technology for higher-order skill in reading class (HR)	Low	78	0	20	10.54	8.40
	High	61	45	1425	104.43	176.65
Teachers use of technology for higher-order skills in math class (HM)	Low	19	5	15	8.95	3.15
	High	17	20	50	30.59	8.82
Teachers use of technology for basic skill in reading class (BR)	Low	76	0	10	2.93	4.37
	High	61	30	150	53.89	27.64
Teachers use of technology for basic skill in math class (BM)	Low	64	0	10	2.98	4.37
	High	76	30	150	54.89	27.96

Covariate

SES: When SES was used as a covariate, the percentage of low-income children in the school was used as the indicator for school SES.

Dependent Variables

The dependent variables in this study are:

1) 5^{th} grade reading mean scores in 2001
2) 5^{th} grade reading mean gain scores from 2000 to 2001 (2000-01)
3) 5^{th} grade math mean scores in 2001
4) 5^{th} grade math mean gain scores from 2000 to 2001 (2000-01)
5) Teacher's Use of Technology for Higher-order Skills
6) Teacher's Use of Technology for Basic skills

Participants

The data from 1,381 Pennsylvania area schools was used to determine computer/student and Internet/student ratios. Based on these ratios, schools were classified as the bottom of 1/3 as low, the middle of 1/3 as middle, and the top of 1/3 as high. 639 principals, whose schools were categorized as having high and low ratios of computers per student or computers with the Internet connection per student, were sampled for this study. Table 3.2 displays participants in each category and return rate. From the each category, 305 schools with the high computer and the high Internet access (HC/S + HI/S), 68 schools with the high computer and the low Internet access (HC/S +

LI/S), 1 school with the low computer and the high Internet access (LC/S + HI/S), and 265 schools with the low computer and the low Internet access (LC/S + LI/S) were selected to gather the data for the questions concerning the relationship between the availability of computers and Internet access and teachers' use of technology for higher-order and basic skills and how time spent with technology effects student achievement. However, the one school with the low computer and the high Internet access (LC/S + HI/S) was not used as a variable in this study due to the small number of case.

Table 3.2

Summary of cross tabulation on the ratio of students per computer and the ratio of students per computer with Internet connection and survey return rate

The Ratio of Computers per Student (C/S)	The Ratio of Internet Connections per Student (I/S)			Total
	High Internet (HI/S)	Middle Internet (MI/S)	Low Internet (LI/S)	
High Computer (HC/S)	305 93 returned	88	68 15 returned	461
Middle Computer (MC/S)	142	202	116	460
Low Computer (LC/S)	1	194	265 71 returned	460
Total	448	484	449	1381

The survey was mailed to the 639 principals with return envelopes, addressed to the Pennsylvania State University in an attempt to increase the return rate.

Instruments

To answer questions concerning the effects of the number of computers and Internet connections on student achievement, the Pennsylvania School Data Profile was used. Among 3,353 schools in Pennsylvania, only schools that met the following criteria were selected:

- Have 5^{th} grade students, and
- 5^{th} graders PSSA Reading mean scores in 2000 and 2001 were available, and
- 5^{th} graders PSSA Math mean scores in 2000 and 2001 were available, and
- The total number of students in the school was available, and
- The number of computers in the school was available, and
- The number of computers with Internet connection was available, and
- The percentage of low-income children was available.

Therefore, the data of 1,381 schools, out of all 1,779 schools that have 5^{th} grade students, were analyzed in this study.

The School Data Profiles

To answer the research questions concerning the effects of the ratio of computers per student and the ratio of Internet connections per student on students achievement, the "School Enrollment and Class Size", "Student Attend, Low Income, and Title I"

"Technology and Resources", and "PSSA - School Results" files from the school data profiles provided by the Pennsylvania Department of Education were used in this study.

Student Enrollment and Class Size

This data file includes the 2000-2001 school year enrollments for each school by grade. In this study, the total number of students in the school was used, because the numbers of computers and Internet connection are also for the whole school.

Student Attend, Low Income, and Title I

This data file includes a variable named "Percent Low Income (School Year 2000-01)". This variable is the percentage of children in the school classified as low income. In this study, the percentage of low-income children in a school analyzed as the indicator of school SES.

Technology and Resources

The variables represented in this data file provide school-level information that describes availability of computers and Internet connection to students. All information is for school year 2000-2001 and was provided by the schools to the Pennsylvania Department of Education (PED). In this study, the number of computers, and the number of computers with Internet access were used in the analyses.

<u>PSSA - School Results</u>

The annual Pennsylvania System of School Assessment (PSSA) is a standards based, criterion-referenced assessment used to measure a student's attainment of the academic standards while also determining the degree to which school programs enable students to attain proficiency of the standards.

This data presents the 2001 school-level state assessment information provided by PDE. Information is presented for grades 5, 8, and 11 in reading and math.

In this study, 5^{th} grade reading and math mean scores were analyzed. Also, Reading and math gain scores of 5^{th} graders from 2000 to 2001 were calculated.

Technology Use Survey

To answer the questions concerning the relationship between the availability of computers and Internet access and teachers' use of technology for higher-order and basic skills and how time spent with technology effects student achievement, a questionnaire has been developed asking about 5^{th} grade teachers' use of technology in their classrooms. 639 principals were asked to describe their 5^{th} grade teachers' use of technology. If they were not sure, they were encouraged to ask to their 5^{th} grade teachers about their use of technology.

The Technology Use Survey was designed to investigate how 5^{th} grade teachers used technologies in their reading and math classrooms (See Appendix C). The survey questions were categorized by high-level skills and basic skills according to Bloom's Taxonomy. This was a short answer and paper-and-pencil survey, containing:

- 6 questions about using computers for high-level skills in reading and math at the Analysis, Synthesis, and Evaluation levels according to Bloom's Taxonomy.
- 5 questions about using computers for basic skills in reading and math at the Knowledge, and Comprehension levels according to Bloom's Taxonomy.
- Opportunities for principals to add examples of technologies used in ways not covered in the survey questionnaire.

<u>Validity</u>

To establish face validity of the survey questionnaire, 3 graduate students from the Instructional Systems graduate program at the Pennsylvania State University reviewed the survey items. Each looked at each question and assessed which of the Bloom's Taxonomy level the question represented, and rated their confidence in their response, using scale from 1 (weak) to 10 (Strong) (See Appendix C). Only items, which had received 7 or more scores from all reviewers, were selected as survey questions.

Reviewers agreed that the questions 1 to 6 were represented as technology uses for basic skills, with all reporting confidence scores 10, and questions 7 to 11 were identified as technology uses for higher-order skills, with all 10 scales. Since reviewers were in disagreement about question 12, that question was removed from the survey.

Data Analysis Procedure and Method

To answer research questions, 1 and 2, related to the effects of technology access on student achievement was employed, while controlling SES. To address questions, the effects of the ratio of computers per student and SES on student achievement, a two-way multivariate Analysis of Variance (Two-way MANOVA) was performed. Because the overall two-way MANOVA results were statistically significant, a two-way analysis (Two-way ANOVA) was used to identify where the differences reside. Since the overall two-way ANOVA of the effect of the ratio of computers per student on the reading gain scores and the math scores were not statistically significant, a one-way ANOVA were performed to examine where the differences reside. To address questions, the effects of the ratio of Internet connections per student on student achievement, a two-way MANOVA was performed. Because the overall two-way MANOVA results were not statistically significant, a one-way ANOVA performed. The post hoc tests of group differences was used to identify where the differences reside. The Tukey method was used for post-hoc results, since the size of group is large. A Chi-square test was used to address question 5, addressing technology access and how teachers use technology. Finally, multivariate analysis of variance (MANOVA) was performed in response to research question 6. Because the MANOVA results were not statistically significant, an analysis of variance (ANOVA) was not performed. Table 3.3 presents the description of variables with sample distribution, coding information and statistical method in each question.

The results of the analyses are reported in Chapter 4.

Justification for using MANCOVA:

Multivariate analysis of covariance is used to determine how each dependent variable is influenced by independent variables while controlling for a covariate (Adelheid, A. M. N., & Penny, M. Pexman, 1999). MANCOVA is to reduce the size of the error term in the analyses thereby increasing power (Stevens, 1986). Analysis of covariance adjusts the mean of each dependent variable to what they would be if all groups started out equally on the covariate. In this study, SES has been shown to correlate with the dependent variable, thus it should be considered as possible covariates.

Justification for using Two-Way MANOVA:

Two-Way MANOVA is used to examine the effects of two or more independent variables on a set of dependent variables (Stevens, 1986). A two-way MANOVA enables us to (1) examine the joint effect of the independent variables on the dependent variables, and (2) get more powerful tests by reducing error (within-cell) variance (Stevens, 1986).

Justification for using MANOVA:

MANOVA is a procedure for analysis of variance and covariance for models containing two or more dependent variables (Stevens, 1986). MANOVA is performed for two reasons: (1) greater statistical power for detecting true differences; and (2) control of false positive results (Type I error). However, MANOVA presumes that interval data is used. Therefore, the use of MANOVA for this study, in which ordinal data is used, becomes a concern.

Justification for using Chi-Square:

The Chi-square method is appropriate because it is used most frequently to test the statistical significance of results reported in bivariate tables (Connor-Linton, 2001).

Independent Variables

The Ratio of Computers per Student

To determine this ratio, a student to computer ratio was first calculated. To do this, the student total enrollment was divided by the number of computers in the school. The ratio was categorized from lowest to highest, with the bottom 1/3 classified as low, the middle 1/3 as middle, and the top 1/3 as high.

These ratios were then reclassified to create a “computer to student” ratio classification for each school. A high computer/student ratio means that the school has many computers compared to the number of students, while a low computer/student ratio means that the school has few computers compared to the number of students. A middle computer/student ratio means that the school’s ratio was neither low nor high.

Data sources were “Schools Enrollment and Class Size” and “Technology and Resources” from the Pennsylvania Department of Education.

The Ratio of Computers with Internet Connection per Student

To determine this ratio, a student to Internet connection ratio was first calculated. To do this, the student total enrollment was divided by the number of computers with Internet connection in the school. The ratio was categorized from lowest to highest, with the bottom 1/3 classified as low, the middle 1/3 as middle, and the top 1/3 as high.

These ratios were then reclassified to create an "Internet to student" ratio classification for each school. A high Internet connection/student ratio means that the school has many Internet connections compared to the number of students, while a low Internet connection/student ratio means that the school has few Internet connections compared to the number of students. A middle Internet connection/student ratio means that the school's ratio was neither low nor high.

Data sources were "Schools Enrollment and Class Size" and "Technology and Resources" from the Pennsylvania Department of Education.

The School SES

The percentage of low-income children in a school was categorized as three groups: low, middle, and high SES. These three groups were used for questions 3 and 4 as using Two-Way MANOVA. The high SES category may be viewed as a wealthy school, and the low SES category represents poorer schools.

Data source was "Student Attendance, Low Income, and Title I" from the Pennsylvania Department of Education.

The Availability of Computers and Internet Connections

Schools were categorized into three groups, based on the ratio of computers per student and three groups, based on the ratio of computers with Internet connection per student. These classifications were crossed to address question 5, to form three groups of schools, those with a high c/s + high i/s, those with a high c/s + low i/s, and those with a low c/s + low i/s.

- Of schools classified as having high computer and high Internet connection ratios (Hc/s + Hi/s), 93 schools out of 305 returned the survey.
- Of schools classified as having high computer and a low Internet connection ratios (Hc/s + Li/s), 15 schools out of 68 returned the survey.
- Of schools classified as having low computer and a high Internet connection ratios (Lc/s + Hi/s), only 1 school out of 1 returned the survey. Because only one school fit this classification this group was not used in consideration of this variable.
- Of schools classified as having low computer and a low Internet connection ratios (Lc/s + Li/s), 71 schools out of 265 returned the survey.

Data sources were “Schools Enrollment and Class Size” and “Technology and Resources” from the Pennsylvania Department of Education, and “Technology Use Survey”.

Teacher's Use of Technology for Higher-order Skills

The total minutes of 5th grade teachers' use of technology for higher-order skills was categorized from lowest to highest, with the bottom 1/3 identified as low and the top 1/3 as high.

Data source was "Technology Use Survey".

Teacher's Use of Technology for Basic Skills

The total minutes of 5th grade teacher's use of technology for basic skills was categorized from lowest to highest with the bottom 1/3 identified as low and the top 1/3 as high.

Data source was "Technology Use Survey".

Teacher's Use of Technology for Higher-order Skills in Reading

The total minutes of 5th grade teacher's use of technology for higher-order skills in reading were calculated from the survey questions 7, 8, and 9. These totals were categorized from lowest to highest, with the bottom 1/3 classified as low and the top 1/3 as high.

Data source was "Technology Use Survey," questions 7, 8, and 9.

7. Search the Internet to gather information for projects or reports.
8. Use technology to develop a project, report, or presentation.
9. Use technologies to create their own web pages.

<u>Teacher's Use of Technology for Higher-order Skills in Math</u>

The total minutes of 5th grade teacher's use of technology for higher-order skills in math were calculated from the survey question 11. These totals were categorized from lowest to highest, with the bottom 1/3 classified as low and the top 1/3 as high.

Data source was "Technology Use Survey," question 11.

11. Use a spreadsheet program (like Excel) to explore numeric relationships or to generate charts and graphs.

<u>Teacher's Use of Technology for Basic Skills in Reading</u>

The total minutes of 5th grade teacher's use of technology for basic skills in reading were calculated from the survey question 1. These totals were categorized from lowest to highest, with the bottom 1/3 designated as low and the top 1/3 as high.

Data source was "Technology Use Survey," question 1.

1. Use basic skills software to improve reading skills.

<u>Teacher's Use of Technology for Basic Skills in Math</u>

The total minutes of 5th grade teacher's use of technology for basic skills in math were calculated from the survey question 2. These totals were categorized from lowest to highest, with the bottom 1/3 identified as low and the top 1/3 as high.

Data source was "Technology Use Survey," question 2.

2. Use basic skills software to improve math skills

Covariate

The School SES

The percentage of low-income children in a school was categorized as three groups with low, middle, and high SES. These three groups were used during analysis of for questions 1 and 2. The high SES category indicated a rich school, and the low SES category represented a poor school.

Data source was “Student Attendance, Low Income, and Title I” from the Pennsylvania Department of Education.

Dependent Variables

5th grad reading mean scores in 2001

This is the mean of PSSA 5th grade reading scores for the school. The data source was the “PSSA - School Results”.

5th grade reading gain scores from 2000 to 2001 (2001-2000)

The reading gain score was calculated by subtracting the mean score for 2000 from the mean score for 2001. The data source was the “PSSA - School Results”.

5th grade math mean scores in 2001

This is the mean of PSSA 5th grade math scores for the school. The data source was the “PSSA - School Results”.

5th grade math gain scores from 2000 to 2001 (2001-2000)

The math gain score was calculated by subtracting the mean score for 2000 from the mean score for 2001. The data source was the "PSSA - School Results".

Teacher's Use of Technology for Higher-order Skills

The total minutes of using technology for higher-order skills per week was calculated. The data source was the "Technology Use Survey".

Teacher's Use of Technology for Basic Skills

The total minutes of using technology for basic skills per week was calculated. The data source was the "Technology Use Survey".

Table 3.3

Description of variables with sample distribution, coding information and statistical method in each question

Research Question	Variable Description, Coding Information and Sample				Statistical Method
	Dependent Variables	Independent Variables	Coding	Covariate	
1-1 ~1-4 The relationship between the ratio of computers per student in a school and student achievement.	5th grade Reading mean in 2001 5th grade Reading mean Gain (2000-01) 5th grade Math mean in 2001 5th grade Math mean Gain (2000-01)	Computers per Student ratio (C/S)	High Computer (1) Middle Computer (2) Low Computer (3)	SES	MANCOVA
2-1 ~ 2-4 The relationship between the ratio of computers with Internet access per student and student achievement.	5th grade Reading mean in 2001 5th grade Reading mean Gain (2000-01) 5th grade Math mean in 2001 5th grade Math mean Gain (2000-01)	Computers with Internet Access per Student ratio (I/S):	High Internet (1) Middle Internet (2) Low Internet (3)	SES	MANCOVA
3-1 ~ 3-4 The relationship among the ratio of computers per student in a school, SES and student achievement.	5th grade Reading mean in 2001 5th grade Reading mean Gain (2000-01) 5th grade Math mean in 2001 5th grade Math mean Gain (2000-01)	Computers per Student ratio (C/S) SES	High Computer (1) Middle Computer (2) Low Computer (3) High (1) Middle (2) Low (3)		Two-Way MANOVA Two-Way ANOVA with Tukey's Post hoc tests
4-1 ~ 4-4 The relationship among the ratio of computers with Internet access per student in a school, SES and student achievement.	5th grade Reading mean in 2001 5th grade Reading mean Gain (2000-01) 5th grade Math mean in 2001 5th grade Math mean Gain (2000-01)	Computers with Internet Access per Student ratio (I/S) SES	High Internet (1) Middle Internet (2) Low Internet (3) High (1) Middle (2) Low (3)		Two-Way MANOVA Two-Way ANOVA MANOVA ANOVA with Tukey's Post hoc tests

Research Question	Variable Description, Coding Information and Sample				Statistical Method
	Dependent Variables		Independent Variables		
				Coding	
5-1 The relationship between either the ratio of computers per student or computers with an Internet access per student and how much time that teachers use these technologies for higher-order skills.	How much time 5th grade teachers assign students to use technologies for higher-order skills	Low (1)	Computers per Student ratio (c/s): Computers with Internet Access per Student ratio (i/s):	Hc/s + Hi/s (1) Hc/s + Li/s (2) Lc/s + Li/s (3)	Chi-Square
		High (2)	Computers per Student ratio (c/s): Computers with Internet Access per Student ratio (i/s):	Hc/s + Hi/s (1) Hc/s + Li/s (2) Lc/s + Li/s (3)	
5-2 The relationship between either the ratio of computers per student or computers with an Internet access per student and how much time that teachers use these technologies for basic skills.	How much time 5th grade teachers assign students to use technologies for basic skills.	Low (1)	Computers per Student ratio (c/s): Computers with Internet Access per Student ratio (i/s):	Hc/s + Hi/s (1) Hc/s + Li/s (2) Lc/s + Li/s (3)	Chi-Square
		High (2)	Computers per Student ratio (c/s): Computers with Internet Access per Student ratio (i/s):	Hc/s + Hi/s (1) Hc/s + Li/s (2) Lc/s + Li/s (3)	

Research Question	Dependent Variables	Independent Variables	Coding	Statistical Method
6-1 ~ 6-4 The relationship between how much time teachers use these technologies for higher-order skills and student achievement.	5th grade Reading mean in 2001 5th grade Reading mean Gain (2000-01) 5th grade Math mean in 2001 5th grade Math mean Gain (2000 - 01)	How much time 5th grade teachers assign students to use technologies for higher-order skills (High)	Low (1) High (2)	MANOVA
6-5 ~ 6-8 The relationship between how much time teachers use these technologies for basic skills and student achievement.	5th grade Reading mean in 2001 5th grade Reading mean Gain (2000-01) 5th grade Math mean in 2001 5th grade Math mean Gain (2000-01)	How much time 5th grade teachers assign students to use technologies for basic skills (Basic)	Low (1) High (2)	MANOVA
6-9 ~ 6-10 The relationship between how much time teachers use these technologies for higher-order skills in reading class and student achievement.	5th grade Reading mean in 2001 5th grade Reading mean Gain (2000-01)	How much time 5th grade teachers assign students to use technologies for higher-order skills in reading class. (Questions 7,8,and 9 from the Survey) (HR)	Low (1) High (2)	MANOVA
6-11 ~ 6-12 The relationship between how much time teachers use these technologies for higher-order skills in math class and student achievement.	5th grade Math mean in 2001 5th grade Math mean Gain (2000-01)	How much time 5th grade teachers assign students to use technologies for higher-order skills in math class. (Question 11 from the Survey) (HM)	Low (1) High (2)	MANOVA
			High (2)	

Research Question	Variable Description, Coding Information and Sample			Statistical Method
	Dependent Variables	Independent Variables	Coding	
6-13 ~ 6-14 The relationship between how much time teachers use these technologies for basic skills in reading class and student achievement.	5th grade Reading mean in 2001 5th grade Reading mean Gain (2000-01)	How much time 5th grade teachers assign students to use technologies for basic skills in reading class. (Question 1 from the Survey) (BR)	Low (1) High (2)	MANOVA
6-15 ~ 6-16 The relationship between how much time teachers use these technologies for basic skills in math class and student achievement.	5th grade Math mean in 2001 5th grade Math mean Gain (2000 - 01)	How much time 5th grade teachers assign students to use technologies for basic skills in math class. (Question 2 from the Survey) (BM)	Low (1) High (2)	MANOVA

CHAPTER 4

RESULTS

This chapter presents the results of the study. The results related to the two research questions concerning the effect of the ratio of computers per student and the ratio of Internet connections per student on student achievement, while controlling school SES, will be reported first, following an overview of the statistical data analysis from the multivariate analysis of variance (MANCOVA). The results of the study for questions concerning the relationship between the ratio of computers per student and the ratio of Internet connections per student and SES on student achievement will be reported, performing a Two-way multivariate analysis of variance (Two-Way MANOVA). Next, the findings from the survey will be summarized using chi-square test for research questions concerning the relationship between the amount of technology and time 5th grade teachers use technologies to develop higher-order skills and basic skills. Finally, the result of the study, in response to the research questions concerning how much time 5th grade teachers use technology to develop higher-order skills and basic skills and student achievement will be reported, using the multivariate analysis of variance (MANOVA). The hypotheses presented in Chapter 1 will be examined.

Findings for Research Question 1: The relationship between the ratio of computers per student and student achievement, while controlling SES

Statistical Data Analysis

1. Is there a relationship between the ratio of computers per student in a school and student achievement?

Table 4.1 present overall means and standard deviations, adjusted means, and standard error of each dependent variable by the ratio of students per computer.

Table 4.1
Means, standard deviations, adjusted means and standard errors for each dependent variable by the ratio of computers per student

Dependent Variables		The Ratio of Computers per Student (C/S)		
		High Computer (HC/S) (N=459)	Middle Computer (MC/S) (N=463)	Low Computer (LC/S) (N=458)
Reading Scores in 2001	Mean	1335.0545	1330.5184	1297.2867
	SD	83.1880	82.9551	93.9045
	Adj. mean	1324.707[a]	1323.704[a]	1314.583[a]
	Std. Error	4.150	2.963	4.268
Reading Gain Scores	Mean	1.0458	-2.0302	-3.1072
	SD	49.7482	47.6525	47.4662
	Adj. mean	3.083[a]	-2.139[a]	-5.042[a]
	Std. Error	3.153	2.251	3.242
Math Scores in 2001	Mean	1339.1503	1333.7365	1298.5120
	SD	85.3860	86.7104	88.4961
	Adj. mean	1332.601[a]	1327.656[a]	1311.250[a]
	Std. Error	4.453	3.179	4.580
Math Gain Scores	Mean	5.1852	3.6933	3.7637
	SD	51.9754	51.9362	50.7385
	Adj. mean	10.229[a]	4.310[a]	-1.927[a]
	Std. Error	3.355	2.396	3.451

Note. a. Evaluated at covariates appeared in the model: S/C * SES = 68.3108, SES = 33.2903.

Table 4.2 presents the results of multivariate analysis of covariance (MANCOVA), showing overall differences for the independent variable of computers per student ratio effect and the four dependent variables of representing standardized test scores, while controlling school SES. The Pillai's Trace was used to evaluate the multivariate (MANCOVA) differences. While the covariate (SES) ($F_{4, 1371}$ = 32.896, p = .000) and the interaction of the independent variable (C/S) and the covariate (SES) ($F_{4, 1371}$ = 3.811, p = .004) had significant main effects, the independent variable, C/S ($F_{8, 2744}$ = 1.787, p = .075) did not have a significant effect on student achievement. Therefore, a further analysis was not performed.

Since a significant interaction of the independent variable (C/S) and the covariate (SES) occurred, the main effect will be manifested in question 3, concerning the relationship between the ratio of computers per student (C/S) and the percentage of low-income children (SES) in a school on student achievement.

Table 4.2
Summary of multivariate analysis of covariance (MANCOVA) results by the ratio of computers per student

Dependent Variable	Multivariate F
SES [a]	**Pillai's Trace 32.896 (p =. 004)****
C/S * SES [a]	**Pillai's Trace 3.811 (p =. 004)****
C/S [b]	Pillai's Trace 1.787 (p =. 075)

Note. [a]df = 4,1371, [b]df = 8,2744.
**p < .01. ***p < .001.

Summary of Hypotheses Tested

Hypothesis 1-1 (LC/S = MC/S = HC/S)

There is no relationship between the ratio of computers per student in a school and 5th graders' PSSA reading scores in the most recent year.

The results showed that there was no statistically significant relationship between the ratio of computers per student in a school and 5th graders' PSSA reading scores in the most recent year, while controlling SES. The null hypothesis is retained.

Hypothesis 1-2 (LC/S = MC/S = HC/S)

There is no relationship between the ratio of computers per student in a school and reading gain scores from the previous year to the most recent.

The results showed that there was no statistically significant relationship between the ratio of computers per student in a school and 5th graders' PSSA reading gain scores from the previous year to the most recent. The null hypothesis is retained.

Hypothesis 1-3 (LC/S = MC/S = HC/S)

There is no relationship between the ratio of computers per student in a school and 5th graders' PSSA math scores in the most recent year.

The results showed that there was no statistically significant relationship between the ratio of computers per student in a school and 5th graders' PSSA math scores in the most recent year, while controlling SES. The null hypothesis is retained.

Hypothesis 1-4. (LC/S = MC/S = HC/S)

There is no relationship between the ratio of computers per student in a school and math gain scores from the previous year to the most recent.

The results showed that there was no statistically significant relationship between the ratio of computers per student in a school and 5th graders' PSSA math gain scores from the previous year to the most recent, while controlling SES. The null hypothesis is retained.

Findings for Research Question 2: The relationship between the ratio of computers with Internet connection per student and student achievement, while controlling SES

Statistical Data Analysis

2. Is there a relationship between the ratio of computers with Internet connection per student and student achievement?

Table 4.3 presents overall means, standard deviations, adjusted means, and standard error for each dependent variable by the ratio of computers with Internet connection per student.

Table 4.3
Means, standard deviations, adjusted means, and standard errors of each dependent variable by the ratio of computers with Internet connection per student

Dependent Variables		The Ratio of Internet Connections per Student (I/S) High Internet (HI/S) (N=448)	Middle Internet (MI/S) (N=484)	Low Internet (LI/S) (N=447)
Reading Scores in 2001	Mean	1337.5446	1317.9132	1307.8076
	SD	84.7882	84.5496	93.3681
	Adj. mean	1329.081[a]	1316.813[a]	1317.481[a]
	Std. Error	4.234	2.909	4.337
Reading Gain Scores	Mean	-.3795	-3.0579	-.5145
	SD	48.3100	49.8419	46.6112
	Adj. mean	-4.882[a]	-3.069[a]	-.834[a]
	Std. Error	3.199	2.198	3.277
Math Scores in 2001	Mean	1342.7679	1321.6529	1307.3154
	SD	84.6412	86.7480	91.1828
	Adj. mean	1335.665[a]	1320.675[a]	1315.493[a]
	Std. Error	4.532	3.114	4.642
Math Gain Scores	Mean	6.3393	2.7686	3.6465
	SD	50.5229	55.2557	48.2695
	Adj. mean	8.996[a]	2.924[a]	.816
	Std. Error	3.406	2.340	3.489

Note. a. Evaluated at covariates appeared in the model: I/S * SES = 67.9487, SES = 33.2903.

Table 4.4 presents the results of a multivariate analysis of covariance, showing overall differences for the independent variable of the availability of computers with Internet connection group effect and the four dependent variables of students standardized test scores, while controlling SES. While the covariate (SES) ($F_{4, 1371}$= 40.812, p = .000) has a main effect, the independent variable (I/S) ($F_{8, 2744}$ = 1.608, p = .117) and the interaction of the independent variable (I/S) and the covariate (SES) ($F_{4,}$

$_{1371}$= .788, p = .533) do not have effect on student achievement. Therefore, a further analysis was not performed.

Table 4.4
Summary of multivariate analysis of covariance (MANCOVA) results by the ratio of computers with Internet connection per student

MANOVA Effect and Dependent Variable	Multivariate F
SES [a]	**Pillai's Trace 40.812 (p =. 000)*** **
SES*I/S	Pillai's Trace .788 (p =. 533)
I/S	Pillai's Trace 1.608 (p =. 117)

Note. [a]df = 4,1371, [b]df = 8,2744.
***p < .001.

Summary of Hypotheses Tested

Hypothesis 2-1(LI/S = MI/S = HI/S)

There is no relationship between the ratio of computers with Internet connection per student in a school and 5th graders' PSSA reading scores in the most recent year.

The results showed that there was no statistically significant relationship between the ratio of computers with Internet connection per student in a school and 5th graders' PSSA reading scores in the most recent year, while controlling SES. The null hypothesis is retained.

Hypothesis 2-2 (LI/S = MI/S = HI/S)

There is no relationship between the ratio of computers with Internet connection per student in a school and reading gain scores from the previous year to the most recent.

The statistical results showed that there was no statistically significant relationship between the ratio of computers with Internet connection per student in a school and 5th graders' PSSA reading gain scores from the previous year to the most recent, while controlling SES. The null hypothesis is retained.

<u>Hypothesis 2-3 (LI/S = MI/S = HI/S)</u>

There is no relationship between the ratio of computers with Internet connection per student in a school and 5th graders' PSSA math scores in the most recent year.

The results showed that there was no statistically significant relationship between the ratio of computers with Internet connection per student in a school and 5th graders' PSSA math scores in the most recent year, while controlling SES. The null hypothesis is retained.

<u>Hypothesis 2-4. (LI/S = MI/S = HI/S)</u>

There is no relationship between the ratio of computers with Internet connection per student in a school and math gain scores from the previous year to the most recent.

The results showed that there was no statistically significant relationship between the ratio of computers with Internet connection per student in a school and 5th graders' PSSA math gain scores from the previous year to the most recent, while controlling SES. The null hypothesis is retained.

Findings for Research Question 3: The relationship between the ratio of computers per student and SES on student achievement

Statistical Data Analysis

3. Is there a relationship between the ratio of computers per student in a school and the school SES on student achievement?

Table 4.5 presents overall means and standard deviations of combinations of two independent variables (S/C and SES) on student achievement.

Table 4.5
Means, standard deviations of combinations of two independent variables (C/S and SES) on student achievement

Variable and Source			Reading in 2001	Reading Gain (2000-01)	Math in 2001	Math Gain (2000-01)
Socio-Economic Status of the School (SES)	Computers per Student ratio (C/S)					
High	High Computer (HC/S) (N = 159)	Mean	1388.4906	3.1447	1388.1761	2.8931
		SD	66.8949	43.7649	66.1974	48.0947
	Middle Computer (MC/S) (N = 176)	Mean	1378.6364	3.4659	1384.6591	7.5000
		SD	67.5139	43.6470	69.1491	53.9047
	Low Computer (LC/S) (N = 128)	Mean	1372.5781	-1.3281	1369.2187	-3.9062
		SD	53.7162	39.2523	62.8535	46.9919
Middle	High Computer (HC/S) (N = 156)	Mean	1336.0897	-.8333	1337.0513	3.7179
		SD	49.2338	46.6692	59.8732	51.8710
	Middle Computer 2.1.2 (MC/S) (N = 147)	Mean	1333.3333	.2041	1332.9932	4.8980
		SD	52.8675	44.2513	62.0143	48.9670
	Low Computer (LC/S) (N = 150)	Mean	1318.3333	-2.0000	1310.6667	.8000
		SD	60.2502	51.0034	56.8722	46.1907
Low	High Computer (HC/S) (N = 144)	Mean	1274.9306	.7639	1287.2917	9.3056
		SD	88.1829	58.6572	96.1149	56.1672
	Middle Computer (MC/S) (N = 140)	Mean	1267.0714	-11.2857	1270.5000	-2.3571
		SD	84.8740	54.4276	87.2879	52.2668
	Low Computer (LC/S) (N = 180)	Mean	1227.2778	-5.3073	1237.8333	11.7222
		SD	90.8239	49.8683	84.0675	55.7010

Table 4.6 presents the results of two-way multivariate analysis of variance, showing relationship effects between the independent variables of the availability of computers and school SES on the four dependent variables of students standardized test scores. The Pillai's Trace was used to evaluate the two-way multivariate (Two-Way MANOVA) differences. The Two-Way MANOVA results showed that there was a statistically significant effect for the ratio of the students per computer on student achievement (F = 6.131, p = .000). There was a statistically significant effect of school SES on student achievement (F = 81.026, p = .000). And, the significant interaction results showed that the effect of the ratio of C/S on student achievement depends on school SES (F = 2.327, p = .002).

Further, the results of the Two-Way ANOVA tests, which are presented in Table 4.6, indicated that there were significant relationships between the two independent variables (C/S and SES) on the reading score (F = 3.336, p = .009) and the math gain score (F = 2.571, p = .036). Also, the two-way ANOVA results showed that there were significant effects of the ratio of computers per student on the reading score (F = 18.176, p = .000) and the math score (F = 22.966, p = .000). The effects of school SES also showed significantly on the reading score (F = 355.492, p = .000) and the math score (F = 287.314, p = .000). Therefore, the effect of the ratio of computers per student on the reading and math gain scores appeared to depend on the level of the percentage of low-income children in a school. However, in reading gain score (F = .972, p = .422) and the math score (F = 1.849, p = .117), there was no relationship.

Table 4.6

Summary of two-way multivariate analysis of variance (two-way MANOVA) results and follow-up two-way univariate analysis of variance results by the ratio of computers per student (C/S), the percentage of low-income children in a school (SES), and student achievement

Dependent Variable	Multivariate F	Univariate
Two-way MANOVA Effect		
C/S [a]	**Pillai's Trace 6.131 (p =. 000)*** **	
SES [a]	**Pillai's Trace 81.026 (p =. 000)*** **	
C/S x SES [b]	**Pillai's Trace 2.327 (p =. 002)** **	
Two-way Univariate Analysis Variance Effect		
Reading in 2001		
C/S [c]		**18.176 (p = .000)*** **
2.1.3 SES [c]		**355.492 (p = .000)*** **
C/S x SES [d]		**3.336 (p = .009)** **
Reading Gain (2000-01)		
C/S [a]		.916 (p = .400)
SES [a]		2.478 (p = .084)
C/S x SES [b]		.972 (p = .422)
Math in 2001		
C/S [c]		**22.966 (p = .000)*** **
SES [c]		**287.314 (p = .000)*** **
C/S x SES [d]		1.849 (p = .117)
Math Gain (2000-01)		
C/S [c]		.287 (p = .751)
SES [c]		.776 (p = .460)
C/S x SES [d]		**2.571 (p = .036) * **

Note

(a) [a]df = 2, 1370, [b]df = 4, 1370, [c]df = 2,1371, [d]df = 4, 1371.

(b) * p < .05. **p < .01. ***p < .001.

The results of the ANOVA tests of the effect of the independent variables on the Reading Gain Scores and the Math Scores in 2001, which are presented in Table 4.7, indicated that there were significant statistical differences in the math scores, with an F ratio of 29.778, significant at the p <. 001 levels. However, in Reading Gain Scores, there were no significant differences, with an F ratio of .913.

Table 4.7
Summary of multivariate analysis of variance (MANOVA) results and follow-up one-way analysis of variance (ANOVA) results by the ratio of computers per student (C/S)

Dependent Variable	Univariate F df = (2, 1377)
ANOVA Effect	
Reading Gain Scores	.913 (p = .402)
Math Scores in 2001	**29.778 (p = .000)**

Table 4.8 provides a summary of post hoc tests on reading mean scores, and math mean scores by the means of the combination of the three levels of each independent variable, i.e., using a 3 x 3 within-subjects Analysis of Variance. There are 36 possible paired comparisons. Looking at the main differences, Table 4.8 shows that there is statistically significant mean difference on reading and math scores between the five combinations of independent variables. Table 4.8 indicates that among poor schools, which have many low-income children, students in schools with high (HC/S) and middle computer/student ratios (MC/S) performed better in reading and math tests than students in schools with low computer/student ratios (LC/S). These results also revealed that in schools with a typical number of low-income students (Middle SES), students in schools

with high computer/student ratios (HC/S) outperformed students in schools with low computer/student ratios (LC/S) in math. Since there were no statistically significant mean differences on the reading gain scores and the math gain scores, they are not displayed in Table 4.8.

Table 4.8
Summary of Post Hoc Tukey comparison among the combinations of two independent variables (C/S) and the percentage of low-income children in a school (SES) on reading and math scores

Combinations Group			Dependent Variables			
			Reading scores in 2001		Math scores in 2001	
SES	C/S	C/S	Mean Difference	Sig.	Mean Difference	Sig.
High	High Computer	Middle Computer	9.8542	.937	3.5170	1.000
	High Computer	Low Computer	15.9125	.610	18.9574	.411
	Middle Computer	Low Computer	6.0583	.998	15.4403	.666
Middle	High Computer	Middle Computer	2.7564	1.000	4.0581	1.000
	High Computer	Low Computer	17.7564	.401	**26.3846**	**.041***
	Middle Computer	Low Computer	15.0000	.657	22.3265	.170
Low	High Computer	Middle Computer	7.8592	.991	16.7917	.584
	High Computer	Low Computer	**47.6528**	**.000*****	**49.4583**	**.000*****
	Middle Computer	Low Computer	**39.7936**	**.000*****	**32.6667**	**.002****

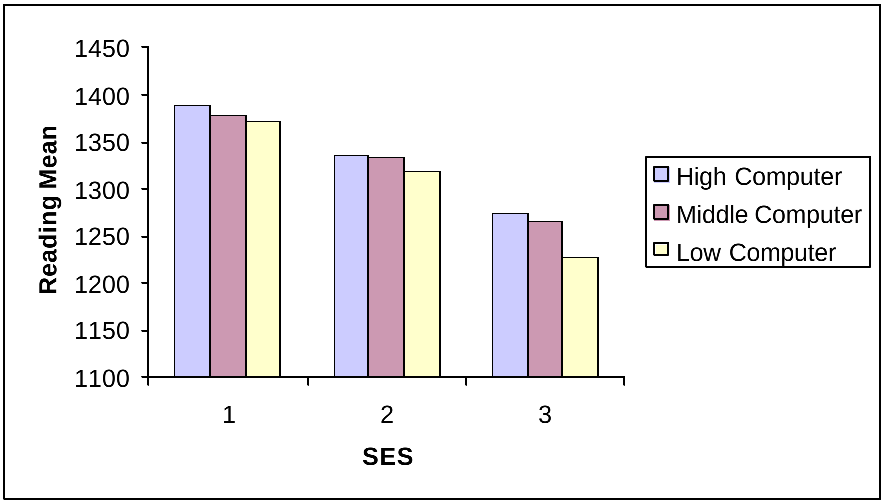
Note. The mean difference shown in this table is the subtraction of the second condition (in the third column) from the first condition (in the second column). For example, 9.8542 (Mean difference for Reading 2001) = Mean for High SES and High Computer – Mean for High SES and Middle Computer.
* $p < .05$. **$p < .01$. ***$p < .001$

The mean differences are discussed below.

Reading Scores in 2001. As Table 4.8, Table 4.9, and Figure 4.1 indicated, among schools with the high percentage of low-income children (Low SES), students in a school with either a high (HC/S) or a middle ratio of computers per student (MC/S) performed better than those in a school with the low ratio of computers per student (LC/S).

Table 4.9
Reading mean scores in 2001 by the ratio of computers per student (C/S) and the percentage of low-income children in a school (SES)

	School Socio-Economic Status (SES)		
The Ratio of Computers per Student (C/S)	High	Middle	Low
High Computer	1388.4096	1336.0897	1274.9306
Middle Computer	1378.6364	1333.3333	1267.0714
Low Computer	1372.5781	1318.3333	1227.2778



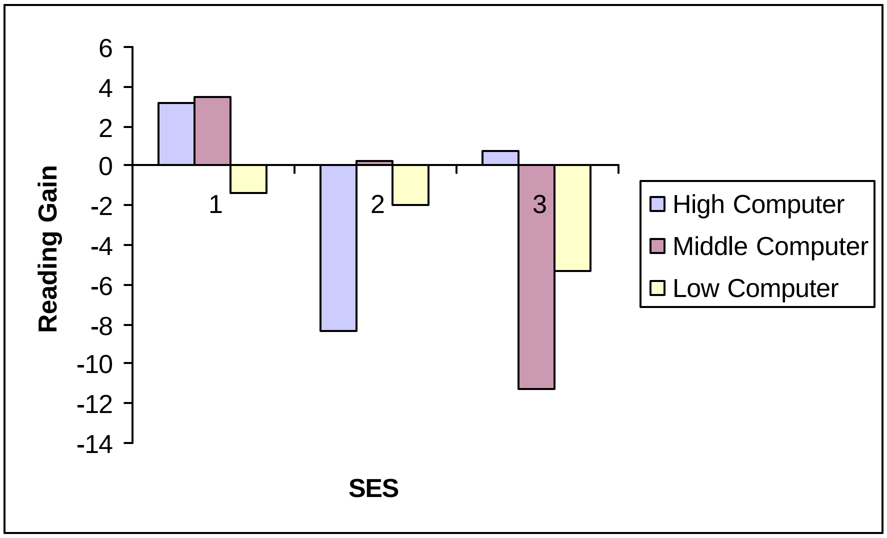
1 = High SES
2 = Middle SES
3 = Low SES

Figure 4.1 Estimated marginal means of reading mean scores in 2001 by the ratio of computers per student and the percentage of low-income children in a school.

Reading Gain Scores. There were no significant differences on reading gain scores.

Table 4.10
Reading gain mean scores in 2001 by the ratio of computers per student and SES

	School Socio-Economic Status (SES)		
The Ratio of Computers per Student (C/S)	High	Middle	Low
High Computer	3.1447	-8.333	.7639
Middle Computer	3.4659	.2041	-11.2857
Low Computer	-1.3281	-2.0000	-5.3073



1 = High SES
2 = Middle SES
3 = Low SES

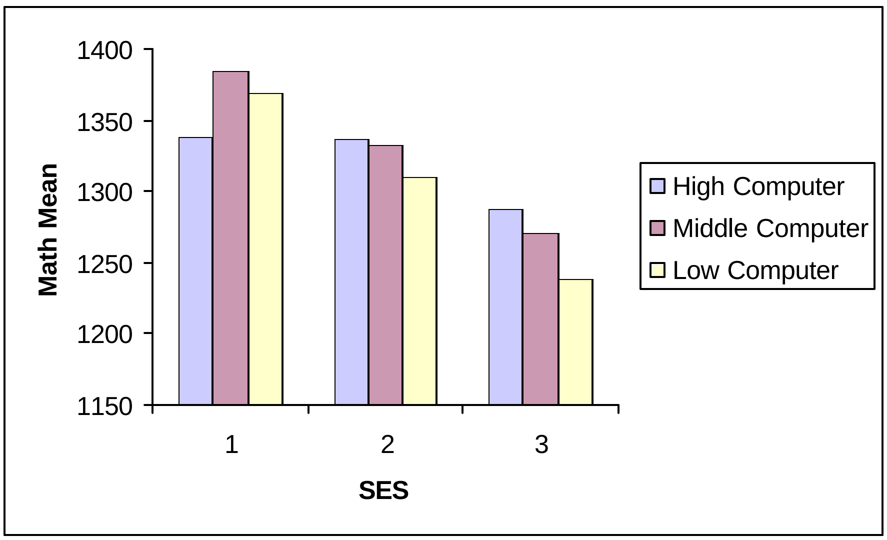
Figure 4.2 Estimated marginal means of reading gain mean scores in 2001 by the ratio of computers per student and the percentage of low-income children in a school.

Math Scores in 2001. As Table 4.8, Table 4.110, and Figure 4.3 indicated, among schools with a high percentage of low-income children (Low SES), students in schools with either a high (HC/S) or a middle ratio of computers per student (MC/S) performed better than those in schools with a low ratio of computers per student (LC/S). Also, among schools with a middle percentage of low-income children (Middle SES), students in schools with a high computer/student ratio (HS/C) performed better than those in schools with a low computer/student ratio (LS/C).

Table 4.11
Math mean scores in 2001 by the ratio of computers per student and SES

The Ratio of Computers per Student (C/S)	School Socio-Economic Status (SES) High	Middle	Low
High Computer	1338.1761	1337.0513	1287.2917
Middle Computer	1384.6591	1332.9932	1270.5000
Low Computer	1369.2187	1310.6667	1237.8333

2.1.4



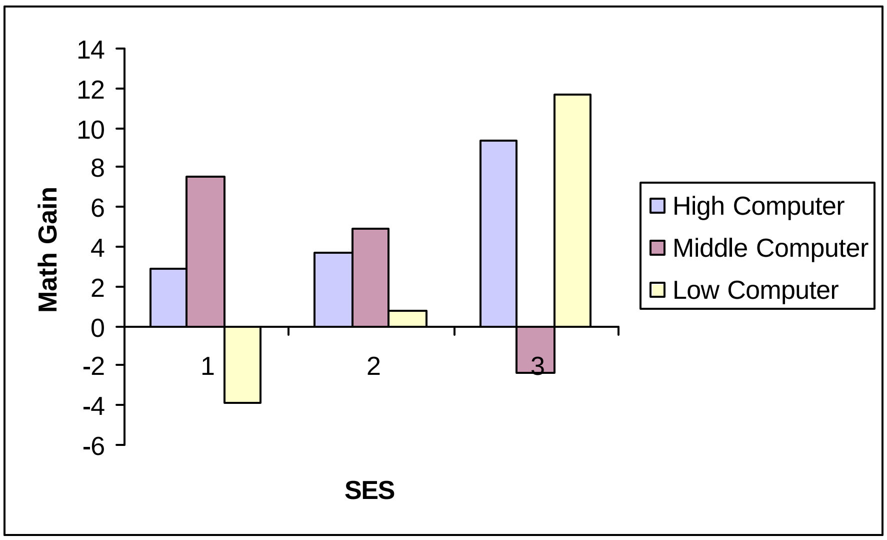
1 = High SES
2 = Middle SES
3 = Low SES

Figure 4.3 Estimated marginal means of math mean scores in 2001 by the ratio of computers per student and the percentage of low-income children in a school.

Math Gain Scores. There were no significant differences among math gain scores.

Table 4.12
Math gain mean scores in 2001 by the ratio of computers per student and SES

The Ratio of Computers per Student (C/S)	School Socio-Economic Status (SES) High	Middle	Low
High Computer	2.8931	3.7179	9.3056
Middle Computer	7.5000	4.8980	-2.3571
Low Computer	-3.9062	.8000	11.7222



1 = High SES
2 = Middle SES
3 = Low SES

Figure 4.4 Estimated marginal means of math gain mean scores in 2001 by the ratio of computers per student and the percentage of low-income children in a school.

Summary of Hypotheses Tested

Hypothesis 3-1.

There is a significant relationship between the ratio of computers per student in a school and SES on 5th graders' PSSA (1) reading scores in the most recent year.

The results showed that there was a significant relationship between the ratio of computers per student in a school and the percentage of low-income children in a school (SES) on reading scores in 2001. And the results indicated that the effect of the ratio of computers per student on the reading scores depends on SES. Particularly, among schools with many low-income children, when a school has many computers compared to the number of students, then its students performed significantly better than students in schools with low ratio of computers per student. The null hypothesis is rejected.

Hypothesis 3-2.

There is a significant relationship between the ratio of computers per student in a school and SES on 5th graders' reading gain scores from the previous year to the most recent.

The results showed that there was no relationship between the ratio of computers per student in a school and the percentage of low-income children in a school (SES) on reading gain scores from 2000 to 2001. Neither the ratio of computers per student nor the percentages of low-income children in a school influenced reading gain scores from 2000 to 2001. The null hypothesis is accepted.

Hypothesis 3-3.

There is a significant relationship between the ratio of computers per student in a school and SES on 5th graders' PSSA math scores in the most recent year.

The results showed that there was not a significant interaction between the ratio of computers per student in a school (C/S) and the percentage of low-income children in a school (SES) on math scores in 2001. However, the ratio of computers per student did have a significant influence on students' math scores in 2001, as does the percentage of low-income children (SES). Comparing mean differences among schools with many low-income children (Low SES), when a school has a high (HC/S) or middle ratio of computers per student (MC/S), its students performed significantly better on the math test than students in schools with a low ratio of computers per student (LC/S). Also, among schools with a middle percentage of low-income children (Middle SES), when a school has many computers (HC/S) compared to the number of students, then its students performed significantly better than students in schools with low computer per student ratios (LC/S).

Hypothesis 3-4.

There is a significant relationship between the ratio of computers per student in a school and SES on 5th graders' PSSA math gain scores from the previous year to the most recent.

The results showed that there was a significant relationship between the ratio of computers per student in a school and the percentage of low-income children in a school (SES) on math gain scores from 2000 to 2001. However, there were no statistically significant mean differences among different SES schools and among different ratio of C/S schools.

Findings for Research Question 4: The relationship between the ratio of computers with Internet connections per student and SES on student achievement

Statistical Data Analysis

4. Is there a relationship between the ratio of computers with Internet connections per student in a school and school SES on student achievement?

Table 4.13 presents overall means and standard deviations of combinations of two independent variables (I/S and SES) on student achievement.

Table 4.13
Means, standard deviations of combinations of two independent variables (I/S and SES) on student achievement

Variable and Source			Reading in 2001	Reading Gain (2000-01)	Math in 2001	Math Gain (2000-01)
School Socio-Economic Status (SES)	The Ratio of Internet per Student (I/S)					
High	High Internet (HI/S) (N = 163)	Mean	1390.1840	.5521	1392.3926	2.6994
		SD	65.7480	43.7762	63.6526	47.2328
	Middle Internet (MI/S) (N = 178)	Mean	1375.8989	3.2584	1377.6966	5.9551
		SD	57.4459	44.1307	62.0987	53.8720
	Low Internet (LI/S) (N = 122)	Mean	1373.6885	2.2131	1372.8689	-1.8033
		SD	69.2844	38.3441	75.4653	48.4984
Middle	High Internet (HI/S) (N = 151)	Mean	1337.6821	1.1258	1337.1523	7.7483
		SD	51.1005	44.4754	58.5989	50.6514
	Middle Internet (MI/S) (N = 145)	Mean	1323.5862	-8.4828	1326.2069	-2.4828
		SD	50.4380	50.1294	58.6665	51.1198
	Low Internet (LI/S) (N = 157)	Mean	1326.5605	4.2038	1317.9618	3.8854
		SD	60.8562	46.6730	63.0907	45.1017
Low	High Internet (HI/S) (N = 134)	Mean	1273.3582	-3.2090	1288.7313	9.1791
		SD	91.6757	48.3100	96.3033	54.2349
	Middle Internet (MI/S) (N = 161)	Mean	1248.6957	-5.1553	1255.5901	3.9752
		SD	83.9578	54.8419	86.3050	60.1382
	Low Internet (LI/S) (N = 169)	Mean	1243.9053	-6.9048	1249.7633	7.3964
		SD	94.1068	51.3291	87.9526	50.6655

Table 4.14 presents the results of a two-way multivariate analysis of variance, showing overall differences for the independent variables of the availability of Internet access group and SES effects, and the four dependent variables of students standardized test scores. The Pillai's Trace was use to evaluate the two-way multivariate (Two-way MANOVA) differences. The two-way MANOVA results showed that there was no

statistically significant relationship between the ratio of Internet connections per student and SES on student achievement (F = 1.147, p = .304). However, the ratio of Internet connections per student (I/S) influenced student achievement (F = 4.451, p = .000), and the percentage of low-income children in a school (SES) influenced student achievement (F = 80.566, p = .000). The two-way univariate (Two-way ANOVA) results showed that there were no significant interactions between the ratio of Internet connections per student and the percentage of low-income children on any of the dependent variables, reading (F = .697, p = .594), reading gain (F = 2.313, p = .263), math (F = 1.223, p = .299), or math gain (F = 1.018, p = .397). However, the ratio of Internet connection per student (I/S) had a significant influence on the reading scores (F = 9.996, p = .000) and the math scores (F = 15.072, p = .000) in the most recent year. The percentage of low-income children in a school (SES) also had a significant influence on the reading scores (F = 353.810, p = .000) and the math scores (F = 286.389, p = .000) in the most recent year. On the other hand, the ratio of Internet connections per student (I/S) did not influence the reading gain scores (F = .658, p = .518) or the math gain scores (F = .809, p = .446) from the previous year to the most recent year. The percentage of low-income children in a school (SES) also did not influence the reading gain scores (F = 2.480, p = .804) or the math gain scores (F = 1.029, p = .358) from the previous year to the most recent year.

Table 4.14

Summary of two-way multivariate analysis of variance (two-way MANOVA) results and follow-up two-way univariate analysis of variance (two-way ANOVA) results by the ratio of computers with Internet connection per student (I/S), the percentage of low-income children (SES), and student achievement

Dependent Variable	Multivariate F df = 80	Univariate
Two-way MANOVA Effect		
I/S [a]	**Pillai's Trace 4.451 (p = .000)*** **	
SES [a]	**Pillai's Trace 80.566 (p =. 000)*** **	
I/S x SES [b]	Pillai's Trace 1.147 (p =. 304)	
Two-way ANOVA Effect		
Reading in 2001		
I/S [c]		**9.996 (p = .000)*** **
SES [c]		**353.810 (p = .001)*** **
I/S x SES [d]		.697 (p = .594)
Reading Gain (2000-01)		
I/S [a]		.658 (p = .518)
SES [a]		2.480 (p = .084)
I/S x SES [b]		2.313 (p = .263)
Math in 2001		
I/S [c]		**15.072 (p = .000)*** **
SES [c]		**286.389 (p = .000)*** **
I/S x SES [d]		1.223 (p > .299)
Math Gain (2000-01)		
I/S [c]		.809 (p = .446)
SES [c]		1.029 (p = .358)
I/S x SES [c]		1.018 (p = .397)

Note. [a]df = 2, 1370, [b]df = 4, 1370, [c]df = 2,1371, [d]df = 4, 1371.
**p < .01. ***p < .001.

Since, there was no relationship found between the two independent variables, the MANOVA and ANOVA tests performed. Table 4.15 presents the results of multivariate analysis of variance, showing overall differences for the independent variable of the availability of computers with Internet connection and the four dependent variables of standardized test scores. The Pillai's Trace was used to evaluate the multivariate (MANOVA) differences. The MANOVA results were statistically significant (F = 5.229, p = .000).

The results of the ANOVA tests, which are presented in Table 4.15, indicated that there were significant statistical differences in the two dependent variables (Reading Scores in 2001 and Math Scores in 2001), with F ratios of 13.035 and 18.736, significant at the p < .001 levels. However, in the other two dependent variables (Reading Gain Scores and Math Gain Scores), there were no statistically significant differences, with F ratios of .460 and .598, at the p > .05 levels.

Table 4.15
<u>Summary of multivariate analysis of variance (MANOVA) and one-way analysis of variance (ANOVA) results by the ratio of computers with Internet connection per student</u>

MANOVA Effect and Dependent Variable	Multivariate F df = 8	Univariate F df = (2, 1377)
Effect	**Pillai's Trace 5.229 (p =. 000)**	
Reading Scores in 2001		**13.035 (p = .000)**
Reading Gain Scores		.460 (p = .632)
Math Scores in 2001		**18.736 (p = .000)**
Math Gain Scores		.598 (p = .550)

Table 4.16 presents the results of Post Hoc Tukey comparison in between the combinations of the three groups representing each independent variable on reading and math achievement, using a 3 x 3 within-subjects Analysis of Variance. Since there were

no statistically significant mean differences found on the reading gain scores and the math gain scores, they were not displayed in Table 4.16.

Table 4.16
Summary of Post Hoc Tukey comparison among the combinations groups of the ratio of Internet connections per student (I/S) and the percentage of low-income children in a school (SES) on reading and math scores

Combinations Group			Dependent Variables			
			Reading scores in 2001		Math scores in 2001	
SES	I/S	I/S	Mean Difference	Sig.	Mean Difference	Sig.
High	High Internet	Middle Internet	14.2852	.647	14.6960	.650
	High Internet	Low Internet	16.4955	.587	19.5238	.391
	Middle Internet	Low Internet	2.2104	1.000	4.8278	1.000
Middle	High Internet	Middle Internet	14.0959	.744	10.9454	.937
	High Internet	Low Internet	11.1216	.909	19.1905	.346
	Middle Internet	Low Internet	-2.9743	1.000	8.2451	.988
Low	High Internet	Middle Internet	24.6626	.074	**33.1413**	**.004****
	High Internet	Low Internet	**29.4529**	**.010***	**38.9680**	**.000*****
	Middle Internet	Low Internet	4.7903	1.000	5.8267	.999

Note. The mean difference shown in this table is the subtraction of the second condition (in the third column) from the first condition (in the second column); for example, 14.2852 (Mean difference for Reading 2001) = Mean for High SES and High Internet – Mean for High SES and Middle Internet.
p < .05. **p < .01. ***p < .001

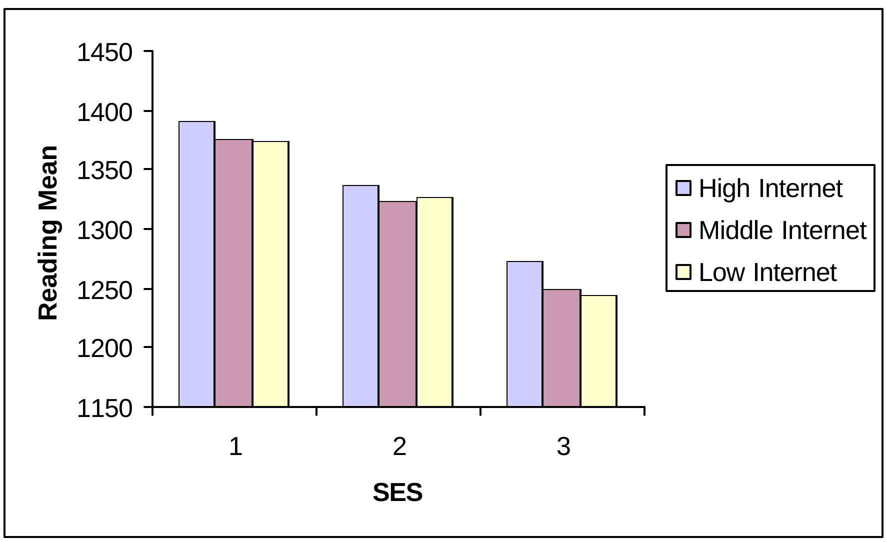
The mean differences are discussed below.

Reading Mean Scores in 2001. As Table 4.16, Table 4.17, and Figure 4.5 indicate, among schools with a high percentage of low-income children (Low SES), students in schools with a high ratio of Internet connections per student (HI/S) performed significantly better than students in schools with a low ratio of Internet connections per student (LI/S) (Mean difference = 29.4529, p = .010).

Table 4.17
Reading mean scores in 2001 by the ratio of computers with Internet connection per student (I/S) and the percentage of low-income children (SES)

The Ratio of Internet Connections per Student (I/S)	School Socio-Economic Status (SES)		
	High	Middle	Low
High Internet	1390.1840	1337.6821	1273.3582
Middle Internet	1375.8989	1323.5862	1248.6957
Low Internet	1373.6885	1326.5605	1243.9053

2.1.5



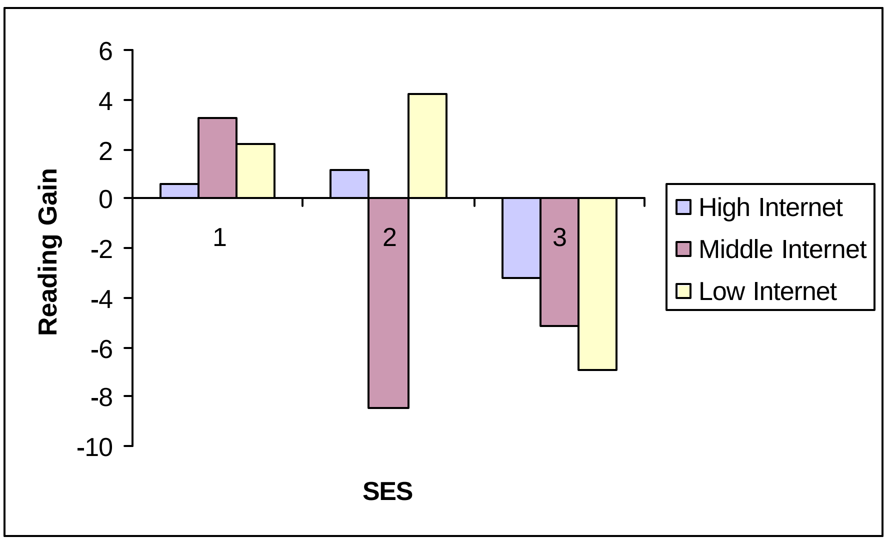
1 = High SES
2 = Middle SES
3 = Low SES

Figure 4.5 Estimated marginal means of reading mean scores in 2001 by the ratio of computers with Internet connection per student (I/S) and the percentage of low-income children in a school (SES).

Reading Gain Scores. There was no significant difference on reading gain scores.

Table 4.18
Reading gain mean scores in 2001 by the ratio of computers with Internet connection per student (I/S) and the percentage of low-income children in a school (SES)

The Ratio of Internet Connections per Student (I/S)	School Socio-Economic Status (SES) High	Middle	Low
High Internet	.5521	1.1258	-3.2090
Middle Internet	3.2584	-8.4828	-5.1553
Low Internet	2.2131	4.2038	-6.9048



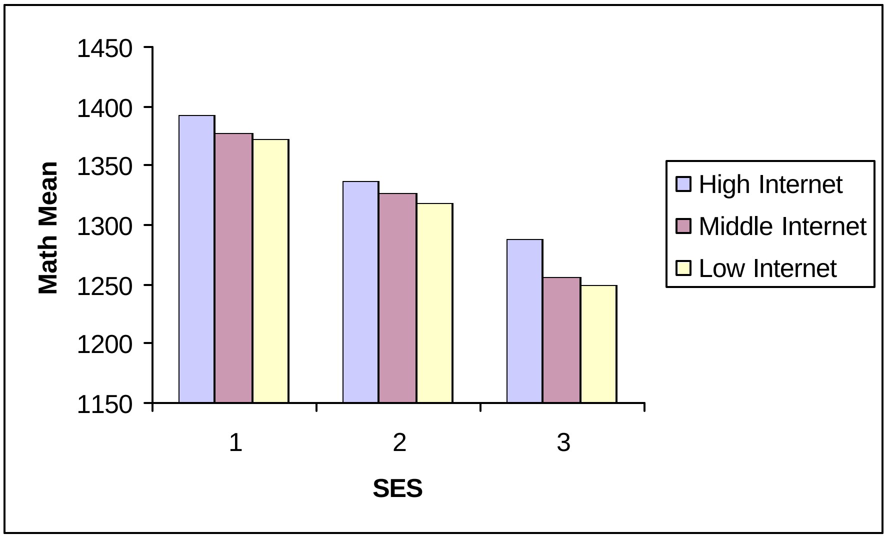
1 = High SES
2 = Middle SES
3 = Low SES

Figure 4.7 Estimated marginal means of reading gain mean scores in 2001 by the ratio of computers with Internet connection per student (I/S) and the percentage of low-income children in a school (SES).

Math Mean Scores in 2001. As Table 4.16, Table 4.19, and Figure 4.7 indicated, among schools with a high percentage of low-income children (Low SES), students in schools with a high ratio of Internet connections per student (HI/S) performed significantly better than students in schools with either a middle (MI/S) (Mean difference = 33.1413, p = .004) or a low ratio of Internet connections per student (LI/S) (Mean difference = 39.9680, p = .000).

Table 4.19
Math mean scores in 2001 by the ratio of computers with Internet connection per student (I/S) and the percentage of low-income children in a school (SES)

The Ratio of Internet Connections per Student (I/S)	School Socio-Economic Status (SES)		
	High	Middle	Low
High Internet	1392.3926	1337.1523	1288.7313
Middle Internet	1377.6966	1326.2069	1255.5901
Low Internet	1372.8689	1317.9618	1249.7633



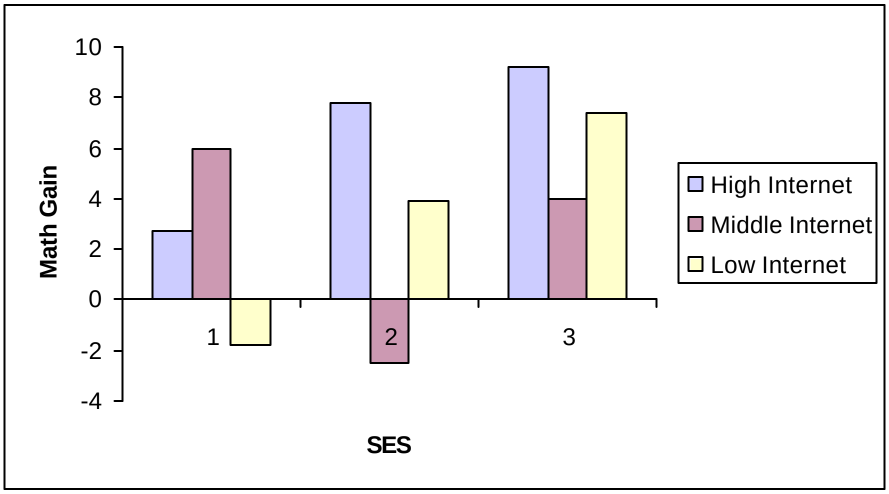
1 = High SES
2 = Middle SES
3 = Low SES

Figure 4.7 Estimated marginal means of math mean scores in 2001 by the ratio of computers with Internet connection per student (I/S) and the percentage of low-income children in a school (SES).

Math Gain Scores. There was no significant difference on math gain scores.

Table 4.20
Math gain mean scores in 2001 by the ratio of computers with Internet connection per student (I/S) and the percentage of low-income children in a school (SES)

	School Socio-Economic Status (SES)		
The Ratio of Internet Connections per Student (I/S)	High	Middle	Low
High Internet	2.6944	7.7483	9.1791
Middle Internet	5.9551	-2.4828	3.9752
Low Internet	-1.8033	3.8854	7.3964



1 = High SES
2 = Middle SES
3 = Low SES

Figure 4.8 Estimated marginal means of math gain mean scores in 2001 by the ratio of computers with Internet connection per student (I/S) and the percentage of low-income children in a school (SES).

Summary of Hypotheses Tested

Hypothesis 4-1

There is no significant relationship between the ratio of computers with Internet connection per student and SES on the 5th graders' reading scores in the most recent year.

The results showed that there was no significant interaction between the ratio of computers with Internet connection per student in a school (I/S) and the percentage of low-income children in a school (SES) on reading scores in 2001. However, both the ratio of Internet connections per student (I/S) and the percentage of low-income children in a school (SES) influenced reading scores. Among schools with high percentage of low-income children (Low SES), when a school has a high ratio of Internet per student (HI/S), its students performed better in the reading test than other students in schools with a low ratio of Internet connections per student (LI/S).

Hypothesis 4-2

There is no significant relationship between the ratio of computers with Internet connections per student and SES on the 5th graders' PSSA reading gain scores from the previous year to the most recent.

The results showed that there was no interaction between the ratio of Internet connections per student in a school (I/S) and the percentage of low-income children in a school (SES) on reading gain scores from 2000 to 2001. Neither the ratio of Internet connections per student (I/S) nor the percentage of low-income children in a school (SES) influenced schools' reading gain scores.

Hypothesis 4-3

There is no significant relationship between the ratio of computers with Internet connections per student and SES on the 5th graders' math scores in the most recent year.

The results showed that there was no significant interaction between the ratio of computers with Internet connections per student in a school (I/S) and the percentage of low-income children in a school (SES) on math scores in 2001. However, both the ratio of Internet connections per student (I/S) and the percentage of low-income children in a school (SES) influenced students' math scores in 2001. Among schools with a high percentage of low-income children (Low SES), students in schools with a high ratio of Internet connections per student (HI/S) performed significantly better than students in schools with either a middle (MI/S) or a low ratio of Internet connections per student (LI/S).

Hypothesis 4-4

There is no significant interaction between the ratio of computers with Internet connection per student and SES on the 5th graders' PSSA math gain scores from the previous year to the most recent.

The results showed that there was no interaction between the ratio of Internet connections per student in a school (I/S) and the percentage of low-income children in a school (SES) on math gain scores from the previous year to the most recent year. Neither the ratio of Internet connections per student (I/S) nor the percentage of low-income children in a school (SES) influenced schools' math gain scores.

Findings for Research Question 5: The relationship between both the ratio of computers per student and the ratio of Internet connections per student and how much time teachers use technologies for higher-order skills and basic skills development.

Statistical Data Analysis

5. Is there a relationship between both the ratio of computers per student and the ratio of computers with Internet connections per student and how much time teachers use these technologies, when teachers' use of technology is classified as "higher-order" and "basic skills," based on the Principal's assessment of technology use according to Bloom's Taxonomy?

Chi-square tests were conducted to determine whether relationships exist between the availability of computers and Internet connections and the time that 5th grade teachers use technology to develop higher-order and basic skills, using cross-tab in SPSS. The following tables show the descriptive statistics and the results of the Chi-square test for each of the variables.

Table 4.21 displays the relationship between the availability of computers and Internet connections and how much time 5th grade teachers use technologies to develop higher-order skills. The Pearson Chi-square shows there was a statistically significant relationship ($p = .025$). This means that the relationship between two categorical variables, the availability of computers and Internet connection and how much time 5th grade teachers use technologies for higher-order skills, is statistically significant. The distribution reveals that teachers who have many computers and Internet connections spend more time using technologies to develop higher-order skills than teachers who have fewer computers and Internet connections.

Table 4.21

Relationship between the availability of computers (c/s) and Internet connections (i/s) and how much time that 5th grade teachers use technologies for higher-order skills

Teachers' Use of Technologies			The Availability of Computers and Internet Connection			
			Hc/s + Hi/s	Hc/s + Li/s	Lc/s + Li/s	Total
Higher-order	Low	Count	29	6	37	72
		% within c/s_i/s	42.0%	60.0%	66.1%	53.3%
	High	Count	40	4	19	63
		% within c/s_i/s	58.0%	40.0%	33.9%	46.7%

Note. Pearson Chi-Square value [a] = 7.372.
[a] 1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.67.
df = 2.
p = .025.

Table 4.22 displays the relationship between the availability of computers and Internet connections and how much time 5th grade teachers use technologies for basic skills. The Pearson Chi-square shows a statistically significant relationship (p = .001). This means that the relationship between the two categorical variables (the availability of computers and Internet connections and how much time 5th grade teachers use technologies for basic skills) is statistically significant. The distribution of schools reflected in Table 4.22 reveals that teachers who have many computers and Internet connections compared to the number of students spend more time using computers to develop basic skills than teachers who have fewer computers and Internet connections.

Table 4.22
Relationship between the availability of computers (c/s) and Internet connections (i/s) and how much time that 5th grade teachers use technologies for basic skills

Teachers' Use of Technologies			The Availability of Computers and Internet Connection			
			Hc/s + Hi/s	Hc/s + Li/s	Lc/s + Li/s	Total
Basic Skills	Low	Count	23	9	29	61
		% within c/s_i/s	34.8%	69.2%	69.0%	50.4%
	High	Count	43	4	13	60
		% within c/s_i/s	65.2%	30.8%	31.0%	49.6%

Note. Pearson Chi-Square value [a] = 14.702.
[a] 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.45.
df = 2.
p = .001.

Summary of Hypotheses Tested

Hypothesis 5-1(Lc/s + Li/s = Lc/s + Hi/s = Hc/s + Hi/s)

There is no relationship between either the ratio of computers per student or Internet connections per student and how much time teachers in the school use these technologies for higher-order skills.

The results showed that there was a significant relationship between either the ratio of computers per student or Internet connections per student and how much time teachers use these technologies for higher-order skills. With many computers and many Internet connections, teachers' use of computer and Internet for higher-order activities is greater. The null hypothesis in rejected.

Hypothesis 5-2 (Lc/s + Li/s = Lc/s + Hi/s = Hc/s + Hi/s)

There is no relationship between either the ratio of computers per students or Internet connections per student and how much time teachers in the school use these technologies for basic skills.

The results showed that there was a significant relationship between either the ratio of computers per student or Internet connections per student and how much time teachers in the school use these technologies for basic skills. With many computers and many Internet connections, teachers' use of computer and Internet for basic skills activities is greater. The null hypothesis in rejected.

Finding for Research Question 6: The relationship between how much time 5^{th} grade teachers uses technologies and student achievement.

Statistical Data Analysis

6. Is there a relationship between how much time teachers use technologies (when teachers' use of technology is classified as "higher-order" and "basic skills," based on the Principal's assessment of technology use according to Bloom's Taxonomy) and achievement test scores?

Table 4.23 displays the means and the standard deviations of each dependent variable by independent variable.

Table. 4.23

Means and standard deviations of each dependent variable by how much time teachers use technologies for "higher-order" and "basic skills"

			Dependent Variables			
Independent Variables			Reading Scores in 2001	Reading Gain Scores	Math Scores in 2001 2.1.6	Math Gain Scores
Higher-Order skills	Low (LHigh) (N=73)	Mean	1331.096	2.0548	1329.4521	1.3699
		SD	67.630	43.8419	68.8979	45.9866
	High (HHigh) (N=63)	Mean	1335.556	5.3968	1335.7143	7.7778
		SD	92.384	48.9840	85.2267	45.0607
Basic skills	Low (LBasic) (N=62)	Mean	1335.806	10.9677	1338.2258	10.6452
		SD	68.030	46.5783	70.1176	48.1756
	High (HBasic) (N=60)	Mean	1327.167	7.5000	1329.0000	5.5000
		SD	95.262	48.0686	88.8095	50.9378
Higher-Order skills in Reading Class	Low (LHR) (N=78)	Mean	1332.308	2.9487		
		SD	71.712	45.5873		
	High (HHR) (N=61)	Mean	1339.180	6.2295		
		SD	83.373	44.1650		
Higher-Order skills in Math Class	Low (LHM) (N = 19)	Mean			1347.3684	7.3684
		SD			58.2945	50.3148
	High (HHM) (N=17)	Mean			1340.588	12.9412
		SD			54.7118	54.7454
Basic skills in Reading Class	Low (LBR) (N= 76)	Mean	1321.974	3.4211		
		SD	77.546	52.4990		
	High (HBR) (N=61)	Mean	1321.967	6.8852		
		SD	93.716	36.5851		
Basic skills in Math Class	Low (LBM) (N = 64)	Mean			1330.4688	11.0937
		SD			68.2765	45.0085
	High (HBM) (N=76)	Mean			1323.2895	14.7368
		SD			94.0835	45.5331

Table 4.24 presents the results of multivariate analysis of variance, showing overall differences for the two independent variables, the time 5th grade teachers use technology and the four dependent variables of standardized test scores. The Pillai's Trace was used to evaluate the multivariate (MANOVA) differences.

None of MANOVA results were statistically significant. Therefore, the ANOVA tests were not performed.

Table 4.24
Summary of multivariate analysis of variance (MANOVA) results by time spending in "higher-order" and "basic skills", and student achievement

	MANOVA Effect	
	df	Multivariate F
Higher-Order skills	4	Pillai's Trace .206 (p =. 934)
Basic Skills	4	Pillai's Trace .173 (p =. 952)
Higher-Order skills in Reading Class	2	Pillai's Trace .172 (p =. 842)
Higher-Order Skills in Math Class	2	Pillai's Trace .131 (p =. 877)
Basic Skills in Reading Class	2	Pillai's Trace .107 (p =. 899)
Basic Skills in Math Class	2	Pillai's Trace .307 (p =. 736)

Summary of Hypotheses Tested

Hypothesis 6-1(LHigh = HHigh)

There is a significant relationship between how much time 5th grade teachers use technologies for higher-order skills and 5th graders' PSSA reading scores in the most recent year.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for higher-order skills and 5th graders' PSSA reading scores. Therefore the null hypothesis is retained.

Hypothesis 6-2 (LHigh = HHigh)

There is a significant relationship between how much time 5th grade teachers use technologies for higher-order skills and 5th graders' PSSA reading gain scores from the previous year to the most recent year.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for higher-order skills and 5th graders' PSSA reading gain scores from the previous year to the most recent year. Therefore the null hypothesis is retained.

Hypothesis 6-3(LHigh = HHigh)

There is a significant relationship between how much time 5th grade teachers use technologies for higher-order skills and 5th graders' PSSA math scores in the most recent.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for higher-order skills and 5th graders' PSSA math scores in the most recent year. Therefore the null hypothesis is retained.

Hypothesis 6-4 (LHigh = HHigh)

There is a significant relationship between how much time 5th grade teachers use technologies for higher-order skills and 5th graders' PSSA math gain scores from the previous year to the most recent year.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for higher-order skills and 5th graders' PSSA math gain scores from the previous year to the most recent year. *Therefore the null hypothesis is retained.*

Hypothesis 6-5 (LBasic = HBasic)

There is a significant relationship between how much time 5th grade teachers use technologies for basic skills and 5th graders' PSSA reading scores in most recent year.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for basic skills and 5th graders' PSSA reading scores in the most recent year. Therefore the null hypothesis is retained.

<u>Hypothesis 6-6 (LBasic = HBasic)</u>

There is a significant relationship between how much time 5th grade teachers use technologies for basic skills and 5th graders' PSSA reading gain scores from the previous year to the most recent.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for basic skills and 5th graders' PSSA reading gain scores from the previous year to the most recent year. Therefore the null hypothesis is retained.

<u>Hypothesis 6-7 (LBasic = HBasic)</u>

There is a significant relationship between how much time 5th grade teachers use technologies for basic skills and 5th graders' PSSA math scores in the most recent year.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for basic skills and 5th graders' PSSA math scores in most recent year. Therefore the null hypothesis is retained.

<u>Hypothesis 6-8 (LBasic = HBasic)</u>

There is a significant relationship between how much time 5th grade teachers use technologies for basic skills and 5th graders' PSSA math gain scores from the previous year to the most recent year.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for basic skills and 5th graders' PSSA math gain scores from the previous year to the most recent year. Therefore the null hypothesis is retained.

Hypothesis 6-9 (LHR = HHR)

There is a significant relationship between how much time teachers use technologies for higher-order skills in reading and 5th graders' PSSA reading scores.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for higher-order skills in reading classes and 5th graders' PSSA reading in the most recent year. Therefore the null hypothesis is retained.

Hypothesis 6-10 (LHR = HHR)

There is a significant relationship between how much time teachers use technologies for higher-order skills in reading and 5th graders' PSSA reading gain scores from the previous year to the most recent year.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for higher-order skills in reading classes and 5th graders' PSSA reading gain scores from the previous year to the most recent year. Therefore the null hypothesis is retained.

Hypothesis 6-11 (LHM = HHM)

There is a significant relationship between how much time teachers use technologies for higher-order skills in math and 5th graders' PSSA math scores.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for higher-order skills in math classes and 5^{th} graders' PSSA math in the most recent year. Therefore the null hypothesis is retained.

<u>Hypothesis 6-12 (LHM = HHM)</u>

There is a significant relationship between how much time teachers use technologies for higher-order skills in math and 5^{th} graders' PSSA math gain scores from the previous year to the most recent year.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for higher-order skills in math classes and 5^{th} graders' PSSA math gain scores from the previous year to the most recent year. Therefore the null hypothesis is retained.

<u>Hypothesis 6-13 (LBR = HBR)</u>

There is a significant relationship between how much time teachers use technologies for basic skills in reading and 5^{th} graders' PSSA reading scores.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for basic skills in reading classes and 5^{th} graders' PSSA reading in the most recent year. Therefore the null hypothesis is retained.

Hypothesis 6-14 (LBR = HBR)

There is a significant relationship between how much time teachers use technologies for basic skills in reading and 5th graders' PSSA reading gain scores from the previous year to the most recent.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for basic skills in reading classes and 5th graders' PSSA reading gain scores from the previous year to the most recent year. Therefore the null hypothesis is retained.

Hypothesis 6-15 (LBM = HBM)

There is a significant relationship between how much time teachers use technologies for basic skills in math and 5th graders' PSSA math scores.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for basic skills in math classes and 5th graders' PSSA math in the most recent year. Therefore the null hypothesis is retained.

Hypothesis 6-16 (LBM = HBM)

There is a significant relationship between how much time teachers use technologies for basic skills in math and 5th graders' PSSA math gain scores from the previous year to the most recent year.

The results showed that there was no significant relationship between how much time 5th grade teachers use technologies for basic skills in math classes and 5th graders'

PSSA math gain scores from the previous year to the most recent year. Therefore the null hypothesis is retained.

Table 4.25 presents a summary of the results in this study.

In the next chapter, the findings of research questions are summarized, followed by a discussion of the implications for educators, suggestions for future research, and limitations of the study.

Table 4.25
Summary of results in each question

Research Question	Independent Variables	Dependent Variables		Statistical Method & Results
1-2 ~1-4 The relationship between the ratio of computers per student in a school and student achievement.	Computers per Student ratio (C/S) Covariate SES SES*C/S	5th grade Reading mean in 2001 5th grade Reading mean Gain (2000-01) 5th grade Math mean in 2001 5th grade Math mean Gain (2000-01)	SES [a] C/S * SES [a] C/S [b]	MANCOVA **Pillai's Trace 32.896 (p =. 004)**** **Pillai's Trace 3.811 (p =. 004)**** Pillai's Trace 1.787 (p =. 075)
2-1 ~ 2-4 The relationship between the ratio of computers with Internet access per student and student achievement.	Computers with Internet Access per student ratio (I/S) Covariate SES SES*I/S	5th grade Reading mean in 2001 5th grade Reading mean Gain (2000-01) 5th grade Math mean in 2001 5th grade Math mean Gain (2000-01)	SES [a] I/S * SES [a] I/S [b]	MANCOVA **Pillai's Trace 40.812 (p =. 000)***** Pillai's Trace .788 (p =. 533) Pillai's Trace 1.608 (p =. 117)

Research Question	Variable Description: Independent Variables	Variable Description: Dependent Variables	Statistical Method & Results: Two-way MANOVA	Two –way ANOVA	Mean Differences SES: H SES	Mean Differences SES: M SES	Mean Differences SES: L SES
3-1 ~ 3-4 The relationship between the ratio of computers per student and SES on student achievement	The Ratio of Computers per Student (C/S) SES	5^{th} grade Reading mean in 2001	**C/S F = 6.131, p = .000*** SES F = 81.026, p = .000*** C/S x SES F= 2.327, p = .002****	**C/S F = 18.176, p = .000*** SES F = 355.492, p = .000*** C/S x SES F = 3.336, p = .009****			HComputer > LComputer MComputer > LComputer
		5^{th} grade Reading mean Gain (2000-01)		C/S F = .916, p = .400 SES F = 2.478, p = .084 C/S x SES F = .972, p = .422			
		5^{th} grade Math mean in 2001		**C/S F = 22.966, p = .000*** SES F = 287.314, p = .000*** C/S x SES F = 1.849, p = .117**		HComputer > LComputer	HComputer > LComputer MComputer > LComputer
		5^{th} grade Math mean Gain (2000-01)		C/S F = .287, p = .751 SES F = .776, p = .460 C/S x SES F = 2.571, p = .036*			

Research Question	Variable Description		Statistical Method & Results				
	Independent Variables	Dependent Variables	Two-way MANOVA	Two –way ANOVA	Mean Differences SES		
					H SES	M SES	L SES
4-1 ~ 4-4 The interaction between the ratio of computers with Internet access per student and SES on student achievement	The Ratio of Computers with Internet Connection per Student (I/S) SES	5^{th} grade Reading mean in 2001		I/S F = 9.996, p = .000 SES F = 353.810, p = .000 I/S x SES F = .697, p = .594			HInternet > LInternet
		5^{th} grade Reading mean Gain (2000-01)	**I/S F = 4.451, p = .000***** **SES F = 80.566, p = .000***** I/S x SES F= 1.147, p = .304	I/S F = .658, p = .518 SES F = 2.480, p = .084 I/S x SES F = 2.313, p = .263			
		5^{th} grade Math mean in 2001		I/S F = 15.072, p = .000 SES F = 286.389, p = .000 I/S x SES F = 1.223, p = .299			HInternet > MInternet HInternet > LInternet
		5^{th} grade Math mean Gain (2000-01)		I/S F = .809, p = .446 SES F = 1.029, p = .358 I/S x SES F = 1.018, p = .397			

Research Question	Variable Description, Coding Information and Sample				Statistical Method
	Dependent Variables		Independent Variables	Coding	
5-1 The relationship between either the ratio of computers per student or computers with an Internet access per student and how much time that teachers use these technologies for higher-order skills.	How much time that 5th grade teachers assign students to use technologies for higher-order skills	Low (1)	Computers per Student ratio (c/s): Computers with Internet Access per Student ratio (i/s):	Hc/s + Hi/s (1) Hc/s + Li/s (2) Lc/s + Li/s (3)	Chi-Square Pearson Chi-Square value = 7.372 P = .025*
		High (2)	Computers per Student ratio (c/s): Computers with Internet Access per Student ratio (i/s):	Hc/s + Hi/s (1) Hc/s + Li/s (2) Lc/s + Li/s (3)	
5-2 The relationship between either the ratio of computers per student or computers with an Internet access per student and how much time that teachers use these technologies for basic skills.	How much time that 5th grade teachers assign students to use technologies for basic skills.	Low (1)	Computers per Student ratio (c/s): Computers with Internet Access per Student ratio (i/s):	Hc/s + Hi/s (1) Hc/s + Li/s (2) Lc/s + Li/s (3)	Chi-Square Pearson Chi-Square value = 12.702 P = .001**
		High (2)	Computers per Student ratio (c/s): Computers with Internet Access per Student ratio (i/s):	Hc/s + Hi/s (1) Hc/s + Li/s (2) Lc/s + Li/s (3)	

Research Question	Independent Variables	Dependent Variables	Statistical Method & Results
6-1 ~ 6-4 The relationship between how much time that teachers use these technologies for higher-order skills and student achievement.	Higher-order skills (High)	5^{th} grade Reading mean in 2001 5^{th} grade Reading mean Gain (2000-01) 5^{th} grade Math mean in 2001 5^{th} grade Math mean Gain (2000 - 01)	MANOVA F = .206 P = .934
6-5 ~ 6-8 The relationship between how much time that teachers use these technologies for basic skills and student achievement.	Basic skills (Basic)	5^{th} grade Reading mean in 2001 5^{th} grade Reading mean Gain (2000-01) 5^{th} grade Math mean in 2001 5^{th} grade Math mean Gain (2000-01)	MANOVA F = .173 P = .952
6-9 ~ 6-10 The relationship between how much time that teachers use these technologies for higher-order skills in reading class and student achievement.	(Questions 7, 8,and 9 from the Survey) (HR)	5^{th} grade Reading mean in 2001 5^{th} grade Reading mean Gain (2000-01)	MANOVA F = .172 P = .842
6-11 ~ 6-12 The relationship between how much time that teachers use these technologies for higher-order skills in math class and student achievement.	(Question 11 from the Survey) (HM)	5^{th} grade Math mean in 2001 5^{th} grade Math mean Gain (2000-01)	MANOVA F = .131 P = .877
6-13 ~ 6-14 The relationship between how much time that teachers use these technologies for basic skills in reading class and student achievement.	(Question 1 from the Survey) (BR)	5^{th} grade Reading mean in 2001 5^{th} grade Reading mean Gain (2000-01)	MANOVA F = .107 P = .899
6-15 ~ 6-16 The relationship between how much time that teachers use these technologies for basic skills in math class and student achievement.	(Question 2 from the Survey) (BM)	5^{th} grade Math mean in 2001 5^{th} grade Math mean Gain (2000 - 01)	MANOVA F = .307 P = .736

CHAPTER 5

GENERAL DISCUSSION

Overview of the Findings

The purpose of this study was to investigate the effects of the availability of technology on teacher's use of technologies and student achievement. Teachers' use of technologies was reported by principals as how much time in a typical week teachers assigned students to use technologies for higher-order skills development and basic skills development. Students achievement was reported as the results of the PSSA (The Annual Pennsylvania System of School Assessment) standardized tests, and included 5^{th} grade reading mean scores in 2001, 5^{th} grade reading mean gain scores from 2000 to 2001, 5^{th} grade math mean scores in 2001, and 5^{th} grade math mean scores gain from 2000 to 2001. This study, first investigated the relationship between the availability of technology on student achievement, while controlling SES, using the percentage of low-income children in a school as a measures of SES. In addition, this study also investigated whether the effects of the availability of technology on student achievement depends on school SES. The relationship between the availability of technology and how much time 5^{th} grade teachers use technology to develop higher-order skills and basic skills was examined. And, the relationship between teachers' use of technology to develop higher-order skills and basic skills and student achievement was investigated. The findings of research questions are summarized below, followed by a discussion of the implications for educators, suggestions for future research, and limitations of the study.

Findings:

The Ratio of Computers per Student (C/S) and the Percentage of Low-income Children in a School (SES) on Student Achievement

- While controlling SES, the ratio of computers per student did not have a significant effect on student achievement. However, when SES was used as a factor, effects were found, primarily for schools with many low-income students.
- The effects of the computers per student ratios on the reading scores and the math gain scores appeared to depend on the school SES.
- The numbers of computers, regardless of school SES, affected the math mean scores.
- Among schools with a high percentage of low-income children (Low SES), students in schools with either a high (HC/S) or a middle ratio of computers per student (MC/S) performed significantly better in the reading and the math tests than those in schools with a low ratio of computers per student (LC/S).
- Among schools with the middle percentage of low-income children (Middle SES), students in schools with a high ratio of computers per student (HC/S) performed significantly better in the math test than those in schools with a low ratio of computers per student (LC/S).

The Ratio of Computers with Internet Connection per Student (I/S) and the Percentage of Low-income Children in a School (SES) on Student Achievement

- There was no significant interaction between the ratio of Internet connections per student and school SES on student achievement.
- Among schools with a high percentage of low-income children (Low SES), students in schools with a high ratio of Internet connections per student (HI/C) performed significantly better on the reading test than students in schools with a low ratio of Internet connections per student (LI/S).
- On the math test, among schools a the high percentage of low-income children (Low SES), students in schools with a high ratio of Internet connections per student (HI/S) performed significantly better that students in schools with either a middle (MI/S) or a low ratio of Internet connections per student (LI/S).

Availability and Use

- When teachers had many computers and Internet connections available, then they were more likely to assign students to use technologies to develop both higher-order skills and basic skills.

Use and Student Achievement

- The time student spent with technologies does not increase student achievement.

When the school SES was controlled, neither the number of computers nor the number of Internet connections influenced student achievement. However, when SES was used as a factor, effects of the ratio of computers per student and the ratio of Internet connections per student were found, primarily for schools with many low-income students. Although this study controlled SES as a covariate, there may still have been an interaction between the factors and SES.

The effects of the availability of computers on students' reading scores and schools' math gain scores appeared to depend on school SES. This study supports Wenglinsky's finding that family income is one of the conditions moderating student achievement (1998). This study showed that the effect of the number of computers on the reading scores and the math gain scores appeared to depend on the percentage of low-income children in a school, affecting particularly schools with a high percentage of low-income children. Among schools with a high percentage of low-income children, students in schools with many computers and Internet connections performed significantly better in the reading and the math tests than those in schools with few computers and Internet connections. Branigan (2000) found that high-poverty schools were making less use of computers and had less access to computers. And Wenglinsky (1998) found that teachers in a low-income school are least likely to use technology to its full advantage. Although the results of those two studies found that technology had less impact on student achievement, this study found that the technology appears to promote student achievement for high-poverty schools. Therefore, this study suggests that more research on the effects of computers in high-poverty schools is warranted and that leaders on shch schools should consider using technology more.

When teachers had many computers and Internet connections available, they were more likely to assign students to use technologies to develop both higher-order skills and basic skills. The findings related to the relationship between the number of computers and Internet connections and the amount of time teachers spend using technologies for higher-order and basic skills development supported the hypotheses proposing that when teachers have many computers and Internet connections compared to the number of students, they devote more time to assignments in which students use technologies to develop both higher-order and basic skills. This study supported the finding of the Center for Research on Information Technology and Organization in 1999 (Becker, Ravitz, and Wong, 1999), which concluded that teachers who had at least one computer in their classroom for every four students were 3 times more than likely to have students use computers on a regular basis than those who did not have classroom access and used computers in labs. This study also supported earlier research that appropriate technology must be available to establish technologically rich teaching and learning environments (Sheingold and Hadley, 1990; Means and Olson, 1993). This study may be also used as evidence that the absence of enough technology is enough to prevent the integration of technology into teaching and learning. When technologies are available, teachers are more likely to assign student to use technology for higher-order and basic skills development.

The time students spent with technologies did not increase student achievement. The findings related to time spent using technologies and student achievement did not support the hypotheses that how teachers use technologies, when teachers' use of technology is classified according to time spent in higher-order and basic skills, effects student achievement on standardized tests. These results are similar to those reported by Wenglinsky (1998), that students who spent more time on computers in school didn't score any higher than their peers; in fact, they performed slightly worse. Also, this study supported Market Data Retrieval's finding that 86% of teachers' believe that the use of Internet did not improve 3 to 12 graders' academic achievement (in "Net Day: Questioning The Impact of Computers in the Classroom," 1997). Interestingly, there are 144 schools out of 180 that say their teachers do not use technologies to explore numeric relationships or to generate charts and graphs with their students.

However, in this study the total mean minutes for using technology to develop both higher-order and basic skills is 184 minutes per week, 131 mean minutes for basic skill development and 53 mean minutes for higher-order skill development. This is only about 3 hours of using technology in classrooms per week. If computers are only used about 3 hours per week, and if the average number of students per computer is 5.6, then a typical student would only spend 33 minutes using the computers. It is easy to see why there may be little connection between computers use and student achievement. This showed that teachers still assigned not much of time with technology. In addition, the times collected were estimates offered by Principals, which would not be as accurate as actual observation data or data reported by the teachers themselves. For this reason these results should only be considered tentative, and perhaps as indicators that more research on this is warranted.

The Implications for Educators

First, this study suggests that policymakers or school administrators should consider increasing the number of computers and Internet connection in low SES schools. This study found that students in schools with many computers and Internet connections per students and a high percentage of low-income children, performed better in their reading and math tests than those in schools with comparable SES, but few computers and Internet connections. As earlier studies found (Wenglinsk, 1998; Branigan, 2000), students in low-poverty schools use computers and Internet at home, which may promote student achievement, while students in high-poverty schools have less access computers and the Internet at home. Therefore, access to these tools at school may be more important.

Second, this study suggests that policymakers and school administrators should rethink whether their teachers are trained to use technologies in appropriate ways. This study found that there is a significant relationship among the ratio of students per computer and the school SES on student achievement. Additionally, there is a significant relationship between the availability of technologies and how much time teachers assign student to spend with technologies for higher-order and basic skills. Educational leaders should think about how to provide professional development for teachers to effectively integrate technologies into their classroom. Policymakers, educators and teachers should focus on whether teachers have training and how they use computers in the classroom, rather than how much time students spend in front of computers as Wenglinsky suggested (1998). Professional development is one of the considerations that might influence student achievement. But most professional development about computer-related technologies is still emphasizing stand-alone technology skill development (Moursund & Bielefeldt, 1999). Lack of professional development for technology use is one of the most serious obstacles to fully integrating technology into the classroom (Fatemi, 1999). One report estimated that less than a quarter of practicing teachers have managed to integrate technology into the classroom (McKenzie, 1999). Even in schools whose classrooms have functioning computers, a large percentage of teachers do not use these technologies because they don't know how to use computers or how they can use computers to contribute to their teaching in meaningful ways (McKenzie, 1999). To help teachers effectively integrate computer related technologies in their classrooms, helping them discover how they can use technologies in their classrooms is important.

Third, more efforts devoted to successful technology integration will be required. Wenglinsky (1998) found that technology has less impact on 4th graders than 8th graders. A study of 55 New York state school districts found that 42 percent of the variation in math scores and 12 percent of the variation in English scores was accounted for by the addition of technology in high schools (Mann & Shafer, 1997). It may be that investments in technology at the elementary school level do not result in much impact on student achievement, but that similar investments at higher grades do. This study investigated at the 5th grade level. A study at the 8th grade level may show more contribution from technology. Many factors influence successful technology integration, such as leadership, support, professional development, and availability of technicians. These factors should be attended to maximize the investment in technology.

Fourth, this study implies that teachers spend less time using technology for higher order skills than for basic skills. Technology allows students to be more actively thinking about information, making choices, and executing skills than they might be in a typical in teacher-centered classroom. Moreover, when technology is used as a tool to support students in performing authentic tasks, the students are in the position of defining their goals, making decisions, and evaluating their progress (Jonassen, 1996). Technology should be integrated in the way that student engage in continuing search for improved understanding (Wilson, Teslow, & Osman, 1995). ACOT's research established that the introduction of technology into classrooms can significantly increase the potential for learning, especially when it is used to support higher-order skill development (1998). When students are using technology as a tool or a support for communicating with others, they are in an active role as recipients of information transmitted by a teacher, textbook, or broadcast. The student is actively making choices about how to generate, obtain, manipulate, or display information. However, the dependent variables used in this study did not assess higher-order abilities, so the contributions of technology to the development of higher-order outcomes can not be assessed.

The Implications for Future Research

This study, for reasons of accessibility, asked principals to describe teachers' use of technologies. The author suggests additional research asking teachers directly about how they have been using technology in their classrooms, and examining how individual teachers assign time for higher-order and basic skill development. Also, in a school, each teacher may use technology differently in their teaching based on their teaching experience and technology experience. Therefore, examining individual teacher's use of technology, their backgrounds, and their students' achievement will produce more useful results.

This study also suggests examining the effects of the teacher's experience with technology on student achievement, in terms of developing professional development programs. Experts are characterized by more efficient domain-related work habits, because of the routines of automated tasks, increased mental capacity to dedicate to solving complex or unusual problems, the ability to make decisions based on past experience, and the ability to regulate personal learning (Eysenk, Ellis, Hunt, and Johnson-Laird, 1990). Experienced teachers know the context and classroom environment better than inexperienced teachers, thus, they will know about the more important goals in students' learning. The literatures supports the reports that teachers with more experience have greater confidence and are more innovative in their teaching (Marcinkiewicz, 1993-94). By examining exemplary teachers work as they integrate technologies into their classrooms, we can probably apply their work for designing and developing professional development programs.

Also, this study suggests investigating new ways of assessing student achievement. Technology is often introduced to promote research, analysis, problem-solving, and communication process more effectively than traditional resources (Knapp and Glenn, 1996). In conventional schools, assessment focuses on short answer and essay tests that emphasize the ability to recall information, rather than understanding it or applying it in some meaningful way (Knapp and Glenn, 1996). However, with integrating technology in student learning, assessment should focus on student demonstrations of their ability to express, apply and defend knowledge and skills (Knapp and Glenn, 1996). Future research should involve tasks that allow the researcher to systematically evaluate students' thinking while they are learning (Nitko, 1983). Over the past decade, almost all states have increased their use of standardized testing as a way of monitoring the performance of local schools (Elmore and et al., 1990). The question is how well the standardized testing is measuring the learning of students who are exploring and creating in technology-rich learning environment.

Limitations of the Study

We cannot say with certainty that high number of computers or Internet access caused the higher reading and math test scores. To prove that, we would need to withhold those technologies from some students in order to measure its comparative impact on others, or we would need performance measures from students before they saw computers and Internet. Neither situation was feasible.

Also, we should have asked teachers directly, instead of principals, how much time they assigned students to use technologies for higher-order and basic skill development. Although we had encouraged principals to ask their teachers if they were not certain of the answers to some survey questions, it would have been more valid to ask teachers to fill out the survey.

The amount of time students spent using technology that was classified as “high” in this study is not high enough. This is may be due to the fact that the time was a mean for all fifth grade teachers in the school, rather than data for individual teachers. We should have examined individual teachers’ data, so that we could investigate teachers with extremely high uses and teachers with extremely low uses with technology. Since data on computers, Internet connections, and students was available only for a whole school basis, however, it was not possible to do this in this study. However, the potential importance of this finding seems to justify making the investment required to answer this question based on individual teachers rather than schools.

To measure the effects of time spent with computers or Internet for higher-order skill development on student achievement, using PSSA was not totally appropriate. While the PSSA standardized test measures more than basic skill development, it is not the best dependent variable for assessing technology’s contributions to the development of higher order skills.

Another limitation of this study was that we didn’t gather data on students’ home computer or Internet use. As stated in Wenglinsky’s finding (1998), use of home computers or the Internet is another factor that influences student achievement.

REFERENCES

Anderson, R.C., & Krathwhol, D. R. (Ed. 2001). *A taxonomy for learning, teaching, and assessing: a revision of Bloom's Taxonomy of educational objectives*. New York: Longman.

Apple Classrooms of Tomorrow (ACOT). (1998). *Apple K-12 Effectiveness Reports.* Retrieved March 20, 2002, from http://www.apple.com/education/research/

Barron and Goldman. (1994). Integrating Technology With Teacher Preparation. In B. Means. (Ed.). Technology and Education Reform (67-89). *The Reality Behind the Promise*. San Francisco, CA: Jossey-Bass.

Becker, H.J. (1994). *Analysis and trends of school use of new information technologies.* Retrieved April 25, 2002, from http://www.gse.uci.edu/EdTechUse/c-tblcnt.htm

Becker, Ravitz, and Wong. (1999). *Teachers and Teacher-Directed Student Use of Computers and Software.* Retrieved April 25, 2002, from http://www.crito.uci.edu/tlc/findings/computeruse/html/left_defaultmasterborder.htm

Bloom, B. S. (1986). Automaticity. Educational Leadership, 43 (5), 70-77.

Bloom, B.S. (Ed.) (1956) *Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain*. New York ; Toronto: Longmans, Green.

Bloom, B.S., Englehart, M.D., Furst, E.J., Hill, W.H., & Krathwohl, D.R. (1956). *Taxonomy of Educational Objectives, Handbook I- Cognitive Domain*. New York, NY: David McKay.

Branigan, C. (2000). *New study: Technology boosts student performance*. eSchool News. Retrieved April 27, 2002, from http://www.eschoolnews.com/news/showStory

Burns, P. K., and Bozeman, W. C. (1981). Computer-Assisted Instruction and Mathematics Achievement: Is There a Relationship*? Educational Technology*, 21(10), 32-39.

Byrom, E. (1998). *Factors that affect the effective use of technology for teaching and learning: Lessons learned from the SEIR-TEC intensive site schools*. Retrieved April 27, 2002, from http://www.seirtec.org/publications/lessondoc.html

Campbell, D. L., Peck, D. L., Horn, C. J., and Leigh, R. K. (1987). Comparison of Computer-Assisted Instruction and Print Drill Performance: A Research Note. *Educational Communication and Technology Journal*, 35(2), 95-103.

Center for Applied Special Technology: National Consortium on Universal Design for Learning. (1997). *Survey: Student Technology Use*. Retrieved April, 26, 2002, from http://www.cast.org/udl/SurveyStudentTechnologyUse2578.cfm

Chang, H., Henriquez, A., Honey, M., Light, D., Moeller, B., & Ross, N. (1998). *The Union City story: Education reform and technology: Students' performance on standardized tests.* New York: Center for Children and Technology, Education Development Center.

Chung, J. (1997). *A case study: integrating technologies into classroom.* Unpublished manuscript. CA.

Clements & Wilmot, (1995). Reviewing and viewing. *Teaching Children Mathematics*, 1(7), 456-457.

Clouse, R.W. (1992). Computer-based at-risk instructional model. *Journal of Educational Technology Systems*, 20(3), 87-94

Clouse, R.W. (1992). Teaching and Learning with computers. *Journal of Educational Technology Systems*, 20(4), 261-302.

Collins, A. (1991). The Role of Computer Technology in Restructuring Schools. *Phi Delta Kappan*, 73(1), 28-36.

Connor-Linton, J. (1998). *Chi Square Tutorial*. Retrieved June, 12, 2002, from http://www.georgetown.edu/cball/webtools/web_chi_tut.html

Dwyer, D. (1994). Apple Classrooms of Tomorrow: What We've Learned. *Educational Leadership,* 51(7), 4-10.

Dyrli, O. and Kinnaman, D. (1994b). Gaining access to technology: The first step in making a difference for your students. *Technology and Learning,* 14(4), 16-20.

Elmore, R. F. and Associates. (1990). Introduction: On changing the structure of public schools. In R. F. Elmore and et al. *Restructuring Schools: The next generation of educational reform* (ed). (1-28). San Francisco, CA: Jossey-Bass.

eMINTS Evaluation Team Policy Brief. (2001). *Analysis of the 2001 MAP Results for eMINTS Students*. Retrieved May 20, 2002, from http://emints.more.net/evaluation/eschool/adult.html

Eysenck, M. W., Ellis, A. W., Hunt, E. B., & Johnson-Laird, P. N. (1990). *The Blackwell dictionary of cognitive psychology*. Oxford, UK; Cambridge, Mass., USA: Blackwell Reference.

Fatemi, E. (1999, September 23). *Building the digital curriculum: Summary*. Retrieved May 20, 2002, from http://www.edweek.org/sreports/tc99/articles/summary.htm

Glennan, T. K., Melmed, A. (1996). *Fostering the Use of Educational Technology: Elements of a National Strategy***.** Santa Monica, CA: RAND.

Glennan, T. K., & Melmed, A. (1995). *The costs and effectiveness of educational technology: proceedings of a workshop* (Ed). Retrieved April, 20, 2002, from http://www.rand.org/publications/MR/MR682.html

Hawley, D. E., Fletcher, J. D., and Piele, P. K. (1986). *Costs, Effects, and Utility of Microcomputer-Assisted Instruction*. Eugene, OR: University of Oregon.

Jonassen, D. (1996). *Computers in the classroom: Mindtools for critical thinking.* Englewood Cliffs, New Jersey: Pretince-Hall.

Khalili, A., & Shashoani, L. (1994). The effectiveness of computer applications: a meta-analysis. *Journal of Research on Computing in Education*, 27(1), 48-61.

Kulik, C. C., & Kulik, J. A. (1991). Effectiveness of computer-based instruction: An updated analysis. *Computers in Human Behaviour,* 7, 75-94.

Kulik, J. A. (1985). *Consistencies in Findings on Computer-Based Education*. Paper presented at the Annual Meeting of the American Educational Research Association. (ED 263 880).

Kulik, J. A. (1994). Meta-analytic studies of findings on computer-based instruction. In E. L. Baker and H. F. O'Neil, Jr. (Eds.). *Technology assessment in education and training*. Hillsdale, NJ: Lawrence Erlbaum.

Kulik, J. A., and Kulik, C. C. (1987). *Computer-Based Instruction: What 200 Evaluations Say*. Paper presented at the Annual Convention of the Association for Educational Communications and Technology, Atlanta, GA. (ED 285 521).

Kulik, J. A., Kulik, C. C., & Bangert-Downs, R. L. (1985). Effectiveness of computer-based education in elementary schools. *Computers in Human Behavior, 1,* 59-74.

Mann, D. & Shafer, E. (1997). Technology and Achievement. *The American School Board Journal*. Retrieved April 13, 2002, from http://www.asbj.com/achievement/ci/ci10.html

Marcinkiewicz, H.R. (1993-94). Computers and Teachers: Factors Influencing Computer Use in the Classroom. *Journal of Research on Computing in Education*, 26(2), 221-237.

Margaret, R. (1989). The Impact of Computers in Classrooms. *Journal of Research on Computing in Education,* 22(2), 180-189.

McKenzie, J. (1998). Adult technology learning: Creating learning cultures with Just-in-Time support. *From Now On*. Retrieved March 20, 2002, from http://www.fno.org/

McNeil, B. J., & Nelson, K.R. (1990). *Meta-analysis of interactive video instruction: A 10-year review of achievement effects*. (ED321751).

Means, B., & Olson, K. (1993). *Supporting school reform with educational technology*. A paper presented at the American Educational Research Association, Atlanta, Georgia.

Means, B., Blando, J., Olson, K., Middleton, T., Morocco, C., Remz, A., & Zorfass, J. (1993). *Using technology to support education reform*. Washington, DC: U.S. Department of Education. Retrieved April, 20, 2002, from http://www.ed.gov/pubs/EdReformStudies/TechReforms/

Meyer, L. (2001). New challenges. *Education Week, 20(35),* 49-55.

Meyer, L., Orlofsky, G. F., Skinner, R. A., and Spicer, S. (2002). Quality Counts 2002: Building Blocks for Success. *Education Week*. Retrieved March 20, 2002, from http://www.edweek.org/sreports/qc02/

Moursund, D. & Bielefeldt, T. (1999). *Will new teachers be prepared to teach in a digital age?* A national survey on information technology in teacher education. Research report by International Society for Technology in Education, Publication of Milken Exchange on Education Technology.

Net Day: Questioning The Impact of Computers in the Classroom (1997, October, 27). Daily Report Card, Retrieved April 15, 2002, from http://www.ofcn.org/cyber.serv/academy/rptcard/1997/drc766.html

Nitko, A. J. (1983). *Educational assessment of students.* (2nd. Ed.). NJ: Prentice-Hall, INC.

North Central Regional Educational Laboratory (1999). *Hands-on, minds-on learning*. *ParenTech: Parenting in a Digital Age*. Oak Brook, IL: NCREL.

President's Committee of Advisors on Science and Technology. (2000). Report to the President on the Use of Technology to Strengthen K-12 Education in the United States. Retrieved March 20, 2002, from http://www.ostp.gov/PCAST/k-12ed.html

Quality counts '98. Retrieved April, 01, 2002, from http://www.edweek.org/sreports/qc98/

Reid, K. S. (2001). Racial disparities. *Education Week*, 20(35). Retrieved April 17, 2002, from http://www.edweek.org/sreports/tc01/tc01article.cfm?slug=35race.h20

Reigeluth, C. M. (1983, Ed.). *Instructional design theories and models: An overview of their current status*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Rich, Y., & Almozlinob, M. (1999). Educational goal preferences among novice and veteran teachers of sciences and humanities. *Teaching and Teacher Education*, 15(6), 613-629.

Roblyer, M. D., Edward, J., & Havriluk, M. A. (1997). *Integrating educational technology into teaching*. Prentice Hall, Inc.

Rockman, S. (1992). *Learning from technologies: A perspective on the research literature***.** U. S. Office of Technology Assessment. (ED361499).

Sheingold, K., & Hadley, M. (1990). *Accomplished teachers: Integrating computers into classroom practice.* New York, NY: Center for Technology in Education. Bank Street College of Education.

State of States. (2001). *Education Week*, 20(35), 70-104.

Stevens, J. (1986). *Multivariate statistics for the social science (4th ed)*. Mshwas, NJ: Lawrence Erlbaum Associates, Inc.

Tapscott, D. (2000). The digital divide. In R. Pea. (Ed.). *Technology and Learning.* San Francisco, CA: Jossey-Bass.157-154.

Technology Trends 2001. Retrieved March 20, 2002, from http://www.schooldata.com/publications3.html#schools

The Internet, Technology and Teachers: Executive Summary (2001). NetDay Survey 2001. Retrieved March 20, 2002, from http://www.netdaycompass.org/

The National Assessment of Educational Progress: Design 2000-2010. (1999). Retrieved February 27, 2002, from http://www.nagb.org/naep/design2000/

Trotter, A. (1998). Teaching the Basics. *Education week*. Retrieved March 20, 2002, from http://www.edweek.org/sreports/tc98/cs/cs1.htm

Trotter, A. (1999). Preparing Teachers for the Digital Age. *Education Week*. September 23. Retrieved March 25, 2002, from http://www.edweek.org/sreports/tc99/articles/ teach.htm

Wenglinsky, H. (1998). Does It Compute? *The Relationship between Educational Technology and Student Achievement in Mathematics*. Princeton, NJ: Policy Information Center.

Williams, C. (2001). *Stats in brief: Internet access in U.S. public schools and classrooms 1994-99*. National Center for Education Statistics.

Wilson, B., Teslow, J., & Osman-Jouchoux, R. (1995). The impact of constructivism (and postmodernism) on ID fundamentals. In B. B. Seels. (Ed.), *Instructional design fundamentals: A reconsideration.* (137-157). Englewood Cliffs, NJ: Educational Technology Publications.

APPENDIX A

RESEARCH RECRUITMENT AND CONSENT FORMS

Invitation Letter for Research (Sample)

PENNSTATE

Voice: (814) 863-4316
Fax: (814) 865-2632

Kyle L. Peck, Ph.D.
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Instructional Systems Program
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411 Keller Building
The Pennsylvania State University
University Park, PA 16802-3206

December 1, 2002
<<Principal’s Name>>
<<School Name>>
<<School Address>>
<<School City>>, PA <School Zip>>

Dear <<Principal’s Name Goes Here>>,

I know that you have many important ways to spend your time, but I’m hoping that you are willing to take 15 minutes to help us with research we are conducting on the use of technologies in 5^{th} grade classrooms in Pennsylvania. Ji-Sook Chung and I are interested in understanding the number of computers and Internet Connections available to 5^{th} grade teachers and students, how those computers and Internet connections are used, and how they might be related student learning. We believe that the results of this study, “The Effect of the Availability of Technology on Teachers’ Use of Technology and Student Achievement,” will help educators identify the most important ways to use technology in elementary school settings.

To gather the data we need, we have enclosed a simple one-page survey that we ask you to complete and return in the self-addressed envelope. Although your school’s name and number appear on the survey, the data you provide will be combined with data from many other schools, and neither the data you provide nor the fact that your school participated will be made public.

Please feel free to ask any questions you might have about participating in this research, by contacting me using the email address or phone numbers in this letter. Your participation is, of course, voluntary. If you are willing to help us out in this way, please keep this letter for your records and return the survey in the enclosed, self-addressed envelope within two weeks. Completing the survey and returning it to us implies that you have read the information in this letter and consent to participate in this research. If you would like a copy of the results of our study, please make a note to that effect on the survey, and we’ll send them to you as soon as we have completed the study.

Thanks in advance for your assistance!

Kyle L. Peck, Ph.D.
Professor of Education
Head, Department of Adult Education, Instructional
Systems, and Workforce Education and Development
Penn State University

APENDIX B

PSSA RESULTS SAMPLE MATERIAL

The PSSA Results Sample

Data Collection Instrument for School Profiles

2002 Pennsylvania System of School Assessment
Grade 5 Mathematics and Reading: Individual Student Report

Name: STUDENT 5 **District: PENNSYLVANIA SD** **School: PENNSYLVANIA GS**

Highlights: In Mathematics, your scaled score of 1219 indicates achievement at the Basic Performance Level. You scored as high or higher than 33 percent of 5th grade students. You performed better in Mathematical Reasoning than in Number Systems and Relationships.

In Reading, your scaled score of 1252 indicates achievement at the Basic Performance Level. You scored as high or higher than 35 percent of 5th grade students. You performed better in Analyzing/Interpreting Literature than in Research.

Total Mathematics and Reading Results

Two dashes (- -) are reported if you did not participate in the assessment (see "Highlights").

Content Area	Scaled Score	Standard Error	Performance Level Achieved	Percent of Students Statewide Scoring at Each Performance Level			
				Below Basic	Basic	Proficient	Advanced
Mathematics	1219	43	Basic	25.2	21.7	27.3	25.8
Reading	1252	59	Basic	20.3	22.7	38.8	18.2

Results by Academic Standards

To assist in understanding how well you performed in each standard, the following results are presented:

- Points achieved, maximum points possible and average points achieved for students statewide
- A graph that shows the difference between your points achieved and the state average
- Two dashes (- -) are reported if you did not participate in the assessment (see "Highlights").

Because of differences in instructional focus that may occur from grade to grade, the number of questions and possible points differ across Academic Standards. The number of questions measuring an Academic Standard is small compared with the total number of questions. For this reason, the Academic Standards with the most possible points are usually measured more accurately.

PSSA Results for Mathematics Academic Standards

Mathematics Academic Standards	Points Achieved	Points Possible	State Average	Difference Between Points Achieved and State Average -10 -8 -6 -4 -2 0 2 4 6 8 10
2.1 Number Systems and Relationships	6	14	8.9	
2.2 Computation and Estimation	11	15	11.2	
Without a Calculator	7	7	5.6	
With a Calculator	4	8	5.6	
2.3 Measurement and Estimation	5	9	5.6	
2.4 Mathematical Reasoning	5	5	3.4	
2.6 Statistics and Data Analysis	3	10	5.5	
2.7 Probability and Predictions	2	5	3.3	
2.8 Algebra and Functions	5	7	4.6	
2.9 Geometry	5	10	5.8	
2.10 Trigonometry	2	5	2.7	
2.11 Concepts of Calculus	4	5	3.8	
2.5 Mathematical Problem Solving *	7	15	7.2	
TOTAL MATHEMATICS	48	85	54.6	

* All items for Academic Standard 2.5, *Mathematical Problem Solving*, are also included in other Academic Standards. *Total Mathematics* does not include points listed under Academic Standard 2.5.

PSSA Results for Reading Academic Standards

Reading Academic Standards	Points Achieved	Points Possible	State Average	Difference Between Points Achieved and State Average -10 -8 -6 -4 -2 0 2 4 6 8 10
1.1 Reading Independently	8	12	9.3	
1.2 Reading Critically	10	12	8.5	
1.3 Analyzing/Interpreting Literature	15	20	12.6	
1.7 English Language Characteristics	3	8	5.0	
1.8 Research	3	8	5.6	
TOTAL READING	39	60	41.0	

Percentages and state averages are rounded. Therefore, "Total Mathematics" and "Total Reading" may vary slightly from the sum of the parts.

Please turn over for additional information

Source: http://www.datarecognitioncorp.com/paparent

Data Collection Instrument for School Profiles

School-Level Data

Source: http://www.paprofiles.org/pa0001/datafiles/datafiles.htm

Please provide the e-mail address for this school. In addition, make any other necessary corrections directly on this label.	**Before completing this form, read the instructions for providing school-level data. The information on this form should pertain only to the school listed in the box.**

Introduction: School Profiles are developed for every public school in the state each year as part of the Pennsylvania System of School Assessment (PSSA). Because some of the information required for the profiles is not available in the Department's files, we must collect certain information directly from the public schools. Each school district, area vocational-technical school (AVTS), charter school, and Scotland School for Veterans' Children is provided with a separate set of forms for each of their public schools.

All information should be completed for the 2000-2001 school year.

L DEADLINE: August 1, 2001

Contents: This form collects school-level information in seven areas: (1) Student attendance and membership, (2) Enrollment stability, student suspensions and expulsions, and grade retention, (3) Length of school day and year, (4) Class Size, (5) Programs available in the school, (6) Teacher attendance and teacher professional development, and (7) Technology and library resources. Please note that several items have been added to the previous data collection instrument.

Technical Support: The contractor, Westat, will provide toll-free technical assistance during the data collection period to all data providers. If you have a question regarding these data collection forms, please contact Beth Sinclair (Westat) at 1-800-449-3503.

Certification:

I certify that the information given in this survey is correct and true to the best of my knowledge and was prepared in accordance with the accompanying instructions.

Chief School Administrator's Signature:	Date:

All completed forms should be returned to the district or AVTS School Profile Coordinator.	You may contact Westat at 1-800-449-3503 for the name of your School Profile Coordinator.

School-Level Data Collection Form

I. Student Attendance, Membership and Truancy

Membership and Attendance

NOTICE: School-level attendance data reported on this page will also be utilized within the School Performance Incentive Program.

Annually, districts and area vocational-technical schools (AVTS) compile membership and attendance data for Department child accounting forms PDE-4062E and PDE-4062S. **Therefore, consult with your district and/or AVTS child accounting specialists when gathering the following information for this specific school:**

> NOTES: If different days in session existed for different groups of students at this school, you need to calculate average daily membership (ADM) and average daily attendance (ADA) for each group of students before calculating school-level totals.
>
> Attendance and membership must only reflect the time students are scheduled to be attending this school. Part-time vocational schools should not report ADA and ADM that relate to scheduled time at the home or sending school. Student ADA and ADM tied to vocational school time should not be included in the sending schools data.

ADA should normally be less than ADM for a school. ADA should never be greater than the ADM for a school.

1. Enter the **Average Daily Membership (ADM)**. This figure is calculated as the aggregate days of membership divided by the number of days in the session. Any full and/or half-time kindergarten programs operating in the school should be included in this calculation.

   ____________ (number)

2. Enter the **Average Daily Attendance (ADA)**. This figure is calculated as the aggregate days of attendance divided by the number of days in the session. Any full and/or half-time kindergarten programs operating in the school should be included in this calculation.

   ____________ (number)

Truancy

3. Enter the number of students enrolled in this school that are classified as habitual truants per the school code:

   ____________ (number)

Definitions:

- **Aggregate Days Membership:** The aggregate days membership for all students of a given school during a given reporting period.
- **Aggregate Days Attendance:** The aggregate days attendance for all students of a given school during a given reporting period.

II.

III. Enrollment Stability, Expulsions, and Grade Retention

Enrollment Stability

4. Enter the number of new students that entered the school **after** the first day of school.

   ____________ (number)

5. Enter the **number of students that withdrew** from the school during the course of the school year. This figure should include all students who are not enrolled in the school on the last day of school but were enrolled in the school at some time during the course of the school year.

_____________ (number)

Student suspensions and expulsions

6. Enter the number of students suspended or expelled during the 2000-2001 school year in each of the appropriate time categories.

Suspension frequency is the total number of students excluded from school for a period of from **one** to **ten** days. This may include in-school or out-of-school exclusion.

Expulsion frequency is the total number of students excluded from school activities for **more than ten days**.

	Total number for 2000-2001	Number by Time Category			
		One time	Twice	Three times	Greater than three times
Suspensions					
Expulsions					

Grade Retention

7. Enter the number of students retained at each grade level.

Grade:	PK	K	1	2	3	4	5	6	7	8	9	10	11	12
Number of students retained from SY 1999-00 to 2000-01:														

III. Length of School Day and Year

8. Enter the length of the school day in this school in hours. Also, indicate if the Kindergartners attend a full-day or a half-day program in the school.

	Hours		Kindergarten program in this school is: (check the appropriate box)	‘	Full-day
Length of school day:				‘	Half-day

9. Enter the **number of contractual days** each teacher in this school was required to report to work in the space provided. The number of **instructional days** should be provided separately from the number of **contractual days**. Keep in mind that the total figure reported under 9c should equal the sum of the figures reported under 9a and 9b.

	Number
9a. Instructional Days:	
9b. Non-Instructional Days:	
9c. **Total** Number of Contractual Days:	

IV. Class Size

10. Provide the following class size information for this school. Indicate the **number of classes** in the appropriate class size categories of the matrix below for this school.

NOTE: For the purpose of this item, **class** is defined as a regular education instructional period dedicated to any of the following four core academic areas: **English/language arts, science** (excluding courses focused on environmental education), **mathematics,** and **social studies**.

Include applied academic classes (applied biology/chemistry, applied communications, principles of technology, and applied math). **Exclude** special education (including gifted) and vocational-technical education classes along with classes such as foreign languages, band, choir, and physical education. If more than one of the core academic areas are taught in a self-contained classroom setting, that classroom should be counted just once.

For example: A teacher provides instruction to the same twenty-five (25) second-grade students in the four core academic areas. This should be treated as one (1) class of twenty-five (25) students.

Class size categories	**Number of classes in this school:**
A. 1-20 students	
• 21-23 students	
• 24-26 students	
• 27-29 students	
• 30 or more students	
Total number of classes	

L **This school does not offer classes in any of the four core academic areas listed above.**

V. Programs Available in the School

11. Which of the following **academic and supporting programs/opportunities/initiatives** are actively supported and/or available to students at this school? Complete the section(s) (elementary, middle/junior high, or high school) most appropriate for your school.

NOTE: This list should not be interpreted as a list of State requirements. The intent is to enable schools to inform school profile users about academic and support programs/opportunities/initiatives that are actively supported and/or available to students at this school. ONLY THOSE ITEMS CHECKED WILL BE PRINTED ON YOUR SCHOOL PROFILE.

EXAMPLES: A school that serves grades K-12 would complete all three sections. A school that serves grades 5-8 would complete both the elementary and middle/junior high school sections. A school that serves grades 7-12 would complete the second and third section. A school that serves grades K-3 would complete the elementary school section.

Elementary School Programs 2000-2001 (Grades K-6)				
Academic Programs/Opportunities/Initiatives			Supporting Programs/Opportunities/Initiatives	
	Full-day kindergarten			Before school programs/clubs
	Half-day kindergarten			After school programs/clubs
	Art instruction with certified art instructors			Intramural sports
	Music instruction with certified music instructors			Band/orchestra
	Acceleration programs			Chorus
	Enrichment programs			Parent involvement programs/organizations
	Tutorial or extra help programs			Business partnerships
	Magnet and/or academy programs			Even start
	Environmental education center			Community service programs/opportunities
	Foreign language instruction with certified foreign language instructor			On-site lunch service
	Physical education instruction with certified physical education instructor			On-site breakfast service
	Independent study courses			Head Start
	Educational field trips			
	Distance learning			
	School to work activities			

Middle/Junior High School Programs 2000-2001 (Grades 6-9)				
Academic Programs/Opportunities/Initiatives			Supporting Programs/Opportunities/Initiatives	
	Required art courses			Before school programs/clubs
	Required music courses			After school programs/clubs
	Acceleration programs			Intramural sports
	Enrichment programs			Band/orchestra
	Tutorial or extra help programs			Chorus
	Magnet and/or academy programs			Theater/arts activities or productions
	Environmental education center			Parent involvement programs/organizations
	Foreign language courses			Business partnerships
	Required physical education courses			Community service programs/opportunities
	Distance learning			On-site lunch service
	Industrial arts/technology education			On-site breakfast service
	Ninth-grade vocational education program(s)			
	Career exploration/career resource center			
	School to work activities			

	Consumer and homemaking education			
	Tech prep			
	Work-based learning			
	Independent study courses			
	Honors programs/courses:			
___ Math ___Sci ___Eng ___Soc Sci ___Arts ___Other				

Senior High School Programs 2000-2001 (Grades 9-12)				
Academic Programs/Opportunities/Initiatives			Supporting Programs/Opportunities/Initiatives	
	Art course cluster or major			Before school programs/clubs
	Music course cluster or major			After school programs/clubs
	Acceleration programs			Intramural sports
	Enrichment programs			Interscholastic sports
	Tutorial or extra help programs			Band/orchestra
	Magnet and/or academy programs			Chorus
	Environmental education center			Theater/arts activities or productions

	Foreign language courses (Non-traditional)			Community service programs/opportunities
	Foreign language courses (Level 5 and above)			Parent involvement programs/organizations
	Required physical education courses			Business partnerships
	Distance learning			Work study
	Independent study courses			On-site lunch service
	School to work activities			On-site breakfast service
	Consumer and homemaking education			
	Tech prep			
	Work-based learning			
	High-Schools -That-Work initiative			
	Higher education course offerings			
	Career exploration/career resource center			
	Industrial arts/technology education			
	Driver education			
	Honors programs/courses:			
___ Math ___Sci ___Eng ___Soc Sci ___Arts ___Other				

VI. Teacher Attendance and Teacher Professional Development

In calculating the figures for items 12, 13, and 14, focus on your school's classroom teachers who provide instruction to public school students (K-12 and ungraded). Include your regular complement of professional staff whose primary assignment is classroom teaching. Exclude short-term and long-term substitutes, reading specialists, and any teachers taking sabbaticals during the 2000-2001 school year.

12. Provide the number of classroom teachers assigned to this school during the 2000-2001 school year:

__________ **(**number**)**

13. Enter the **aggregate number of contractual teacher days of absence for personal reasons** (sick, vacation, sick family, jury duty, bereavement, National Guard duty, etc.) for all classroom teachers in this school. Include only fully-paid leave. Do not count sabbatical leave.

__________________ (number)

14. Enter the **aggregate number of contractual teacher days dedicated to professional development activities for all classroom teachers** in this school. Include any scheduled instructional or non-instructional (Act 48 or district in-service) days specifically used by any teacher for professional development activities. Do not count sabbaticals.

________________________ (number)

Definitions:

- **Number of contractual teacher days of absence for personal reasons:** The aggregate number of teacher days teachers were absent for personal reasons (sick, vacation, sick family, jury duty, bereavement, National Guard duty, etc.). This figure should be calculated using the number of teachers reported in item 5 on this page.
- **Number of contractual teacher days dedicated to professional development activities:** The aggregate number of contractual teacher days that are used for professional development activities for this school. This figure should be calculated using the number of teachers reported in item 5 on this page.
- For the purpose of this item **professional development activities** include:
    - Curriculum development work or other program design and delivery activities
    - Participation in professional conferences or workshops
    - Supervised classroom or peer observation of or formal consultations with other professional employees.

VII. Technology and Library Resources

Technology

15. For each type of equipment or service, please indicate whether or not the service is available for instructional purposes at this school and in other specific settings. (✓ Check all appropriate boxes.)

	Available at school?		**In teacher workrooms?**		**In classrooms?**		**In computer labs?**		**In library/media centers?**	
Equipment/Service:	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
A. **Internet access**										
· **Broadcast television** (NBC, CBS, etc.)										
· **Cable television** (CNN, Learning Channel, Discovery, etc.)										

16. Please indicate the **total number of computers** available in this school for student use.

__________________ (number)

17. Please indicate the **total number of computers** with CD-ROM readers in this school for student use.

____________________ (number)

18. Please indicate the **total number of CD-ROM titles** to which this school has access for student use.

____________________ (number)

19. Please indicate the **total number of computers with Internet Access** available in this school for student use.

____________________ (number)

Libraries

20. Please indicate the **total number of titles in the school library**.

____________________ (number)

21. Indicate the **total number of titles checked out** of the school library. If a book is checked out multiple times, this figure should include all of these times.

____________________ (number)

Definitions:

- For each school, enter the estimated **total number of titles** for books, periodicals, pamphlets, maps, videotapes, films, software, and other electronic media acquired and formally held by the school library using the following guidelines:
    - Count duplicate copies of the same edition as one title
    - Do not count any other holdings acquired or held by individual teachers or classrooms
    - A set of encyclopedias should be counted as one title
    - A CD-ROM package, software package or any other electronic media package containing multiple title reference should be counted as one title.

- **Total number of titles checked out of the school library each year:** This data item is designed to determine the level of library use in the school. The reported figure should estimate the total number of titles checked out of the school library during each year. This figure should include all books, periodicals, pamphlets, maps, videotapes, films, software, and other electronic media that are checked out. If an individual title is checked out more than once the total figure should be reported.

APPENDIX C

USE OF TECHNOLOGY SURVEY MATERIAL

Validation Tool for the Use of Technology Survey Material

Use of Technology Survey Material

Validation Tool for the Use of Technology Survey Material

To Validate this Instrument

Instructional Systems Graduate Students
Here is a list of ways that 5th grade students might use technologies with their students. For each, please indicate whether you see it as a "basic skills" or "higher-level skills" use of technology, by placing a number in the appropriate column. If you are not very confident in your rating, put a low number (one or higher) and if you are very confident, put a number approaching 10, which would indicate that you are certain.

Basic Skills – Knowledge and Comprehensive levels in the Bloom's Taxonomy
Higher-order Skills – Analysis, Evaluation, and Synthesis levels in the Bloom's Taxonomy

Technology Use	Basic Skills 1 10	High-level Skills 1 10
1. Use basic skills software to improve reading skills		
2. Use basic skills software to improve math skills		
3. Use educational games to improve basic skills		
4. Use computers to develop technology skills		
5. Use word processing to develop writing skills		
6. Use computers to access class-related instructional websites		
7. Search the Internet to gather information for projects or reports		
8. Use technology to develop a project, report, or presentation		
9. Use technologies to create their own web pages		
10. Use technologies to create or edit video		
11. Use a spreadsheet program (like Excel) to explore numeric relationships or to generate charts and graphs		
12. Use E-mail, chat rooms, or other technologies for communicating with others		

Use of Technology Survey Material

5th Grade Technology Use Survey

School Name: ____
School Number: ____
Principal's years of experience in the school (include teaching, if applicable): ___________

Directions: We are studying 5th grade teachers' use of technology in their classrooms. Please take a few moments to estimate the answers to the questions below, and then return it to us in the enclosed return envelope.

1. How many computers are there in a typical 5th grade classroom in your school? ___________
2. In a typical 5th grade classroom, how many computers have access to the Internet? __________
3. In your school, do the 5th grade students use a computer lab? Y_____ N_______
4. If your 5th graders do use a computer lab…
   a. how many computers are in the computer lab? __________
   b. how many computers in the computer lab have an Internet connection? _________
5. In a typical week, how many minutes would a typical 5th grade student use a computer in school? ___________ minutes

---

Now, we'd like to ask you to indicate **how** you think 5th grade students in your school use the available computers. In the table below, please read the items in the left column and estimate the **minutes per week** your 5th grade students spend engaged in that activity. If 5th grade students are using technologies in ways not covered in the table below, please add these ways in the blank rows at the bottom, and estimate time.

In a typical week, how many minutes might 5th grade students …	Minutes per week
1. Use basic skills software to improve reading skills	
2. Use basic skills software to improve math skills	
3. Use educational games to improve basic skills	
4. Use computers to develop technology skills	
5. Use word processing to develop writing skills	
6. Use computers to access class-related instructional websites	
7. Search the Internet to gather information for projects or reports	
8. Use technology to develop a project, report, or presentation	
9. Use technologies to create their own web pages	

10. Use technologies to create or edit video	
11. Use a spreadsheet program (like Excel) to explore numeric relationships or to generate charts and graphs	
12.	
13.	
14.	
15. .	
16.	
17.	

VITA

Ji-Sook Chung born and grew up in Seoul Korea. Her interest in educational technology began while she attended the Hankuk University of Foreign Studies in Korea. Although her undergraduate major was German, she came to be interested in the Education Method and Technology class while taking on course in Education Method and Technology. After finishing her B.A., she made a decision to go to the United States because she believed that the programs of Educational Technology and Instructional Systems in United States could give me more opportunities to study as well as to contact the advanced technology itself.

Ms. Chung had studied Curriculum, Teaching, and Educational Technology for M.A. at California State University, Fresno. While studying educational technology in Fresno State, she realized that teachers are most important factor in school reform. During her four years at the Pennsylvania State University, she was a graduate assistant at the Center for Advanced Technology in Altoona School District, designing and development science instructional materials for elementary students; Viewlet programmer at the AECT project, a PT3 Grant, designing and developing online tutorial programs for pre/inservice teachers and teacher educators to introduce how to integrate software programs into their classrooms. She also had opportunities to intern at the State College Area School District, and at the WPSX. These experiences gave lots of opportunities to Ms. Chung to focus on teacher education.

Ji-Sook Chung's future research interest is Problem-Based Learning in teacher education in ways of designing and developing professional development.