Leveraging School District-Wide Achievement through the Use of Technology

By Craig Markson, Ed.D. and Kenneth Forman, Ph.D.

Abstract

The purpose of this study was to examine the relationships among technology use, per pupil spending and school district-wide student achievement. The setting of this study was 94 school districts from New York State's Nassau and Suffolk counties, a suburban region adjacent to New York City. The results of this study showed that technology use had statistically significant and positive correlations with a range of variables that measured student achievement across the school districts' grade levels and subjects. The strongest correlations were with technology use and student achievement on the New York State Grades 3 - 8 English Language Arts and Mathematics assessments. Technology use did not have a strong correlation with per pupil spending, as it only accounted for 7.95 percent of the variance on spending. If the results of this study remain consistent with future studies, school district leaders should continue to leverage student achievement through the use of technology, particularly at the elementary and middle school levels.

I. Purpose

There has been considerable disagreement among the findings of studies in the research literature when it comes to the efficacy of technology in improving student achievement. Older studies have trended toward results that have suggested that the use of technology did not significantly improve student achievement (Angrist & Lavy, 2002; Rouse & Krueger, 2004). However, more recent studies have suggested the opposite (Rashid & Asghar, 2016; Harris et al., 2016). The dissention among these findings might have stemmed from the advancement of technology, devices, and the software that drive them over time. Additionally, the student populations from these studies varied by grade levels and subjects. As a result, one of the purposes of this study was to examine the relationships between the use of technology and student achievement by various subjects and grade levels throughout school districts across Long Island's Nassau and Suffolk counties.

Similar to the relationships between technology use and student achievement, there were contrasting findings among the studies that examined the relationships between per pupil spending and student achievement. These studies also varied over time by student populations, subjects, grade levels, and their results or findings (Cobb-Clark & Jha, 2016; Pugh, Mangan & Gray, 2011; Wenglinsky, 1997). As such, another purpose of this study was to examine the relationships between per pupil spending and student achievement in various subjects and grade levels throughout school districts.

According to the Professional Standards for Educational Leaders (2015), effective educational leaders needed to strategically manage school resources, budgets, and finances for the ultimate goal of promoting student achievement (National Policy Board for Educational Administration [NPBEA], 2015, pp. 17-18). This posed the question as to how technology use impacted school finances and student achievement. As a result, the final purpose of this study was to examine the relationships between the use of technology and per-pupil spending.

II. Theoretical Framework

Technology and Student Achievement

Angrist and Lavy (2002) assessed the short-term consequences of increased computer technology in Israeli elementary schools. Results from a survey of Israeli schoolteachers showed that the influx of new computers increased teachers' use of computer-aided instruction (CAI). Although many of the estimates were imprecise, CAI did not appear to have had educational benefits that translated into higher test scores. The researchers found that insertion of computer technology had a clear impact on the use of computers in elementary school instruction, with a much weaker effect on teaching methods in middle schools. The results reported did not support the view that CAI improved learning, at least as measured by pupil test scores. Using a variety of estimation strategies, Angrist and Lavy found a consistently negative and marginally significant relationship between the use of computers and 4th grade Math scores. For other grades and subjects, the estimates were not significant, though also mostly negative.

Rouse and Krueger (2003) found that although schools across the country have invested heavily in computers in the classroom, there has been little evidence that this actually improves student achievement. The researchers presented results from a randomized study of a well-defined use of computers in schools: an instructional computer program known as Fast ForWord, which was designed to improve language and reading skills. Rouse and Krueger assessed the impact of the program on students having difficulty learning to read using four different measures of language and reading ability. Their estimates suggested that while use of the computer program may have improved some aspects of students' language skills, it did not appear that these gains translated into a broader measure of language acquisition or into actual readings skills.

Lowther, Ross, and Morrison (2003) examined the impact of laptops on classroom activities, and on student use of technology and their writing and problem-solving skills. Results also showed significant advantages for the laptop group on five of the seven components of the problem-solving task. Laptop classes were compared to control classes that did not have extraordinary access to computers. Results indicated greater use of student-centered teaching strategies in the laptop classes, such as project-based learning, independent inquiry, teacher as coach, and cooperative learning. Overall, laptop classes were busier and engaged in more active learning environments. Most revealing was laptop students' superiority in using the computer as a learning tool. More importantly, consistent across both years of the study was laptop students' more frequent use of the computer as a learning tool. The researchers found that laptop students demonstrated superior writing skills as well. In their survey responses, nearly 75% of the laptop students and 100% of the teachers felt that use of laptops improved student writing skills.

Dynarski et al., (2007) in a national study on the effectiveness of reading and mathematics software on achievement found test scores were not significantly higher in classrooms using selected reading and mathematics software products. Test scores in treatment classrooms that were randomly assigned to use products did not differ from test scores in control classrooms by statistically significant margins. For reading products, effects on overall test scores were correlated with the student-teacher ratio in first grade classrooms and with the amount of time that products were used in fourth grade classrooms. For math products, effects were uncorrelated with classroom and school characteristics.

Barrow et al. (2009) primarily assessed computer assisted instruction (CAI) in high school Algebra classes by targeting pre-algebra and algebra skills. Students randomly assigned to CAI classes scored significantly higher on a pre-algebra and algebra tests than students randomly assigned to traditional instruction. The authors hypothesized that this effectiveness arose from increased use of computers for individualized instruction.

Fairlie (2012) found that the achievement gap and resulting earnings gap might have been caused by the underinvestment in educational technology among minority populations. Although financial constraints might have caused a major hindrance for low-income minority students, technical and informational constraints resulting from having less previous experience with computers might be important.

Kiger et al. (2012) found that students using mobile devices (laptops and tablets) outperformed comparison students on a post-intervention multiplication test controlling for prior student achievement and several other covariates. This finding suggested that coupling "business as usual" curriculum with a mobile device may be a cost-effective lever to improve student achievement. Likewise, the researchers found that in-class mobile device involved learning may foster and sustain productive student-teacher learning interactions.

Rashid and Asghir (2016) examined relationships of the number of computer devices in an identified school district with several factors, including per pupil spending and student achievement as exemplified by student graduation rate, English Language Arts (ELA) and Geometry New York State Regents results, and ELA/Math achievement scores grades 3 - 8. We further looked at districts' per pupil spending to determine whether there was a further relationship.

The literature examined did not fully support the relationship of computer devices with achievement. Studies were contradictory. Rashid and Asghir (2016) detailed several sources that supported positive outcomes of student use of technology, where they were able to achieve a greater level of direct engagement with the proposed content, which in turn improved overall achievement. The researchers indicated that technology was highly correlated with student motivation, and also found a significant correlation between technology use and academic achievement.

Additionally, Rashid and Asghir (2016) found that students' long-term knowledge retention in a technology enhanced classroom subsequently influenced learning outcomes. Students who used technology outperformed in both engagement and achievement. This research confirmed the relationship of technology-enhanced student learning with educational outcomes. These findings revealed that compared to non-technology users, students using technology showed significantly higher achievement and had higher scores on criterion referenced standardized tests. These researchers also reported that high school students' intelligent use of electronic devices improved academic performance as measured by GPA.

Harris et al. (2016) set out to determine whether 1:1 technology truly impacted and affected students' academic achievement. The researchers found that 1:1 technology could be a factor in student academic achievement and motivation to be in school. The authors postulated that

with increasing students' technology exposure and concomitantly great teachers' professional development in implementing technology-teaching methodology, 1:1 technology may be the catalyst needed for school districts to help their students achieve at higher levels.

School District Per Pupil Spending and Student Achievement

Wenglinsky (1997) found that per-pupil expenditures for instruction were associated with achievement because the resultant reduced class size raised achievement. Specifically, instructional spending influenced the number of teachers hired per student. Cobb-Clark and Jha (2016) analyzed the relationship between student achievement and schools' budget allocations. The researchers found the opposite, per-pupil expenditure had no apparent link to improvement in students' standardized test scores. However, the allocation of the budget mattered for student achievement in some grades. Ancillary teaching staff were linked to faster growth in numeracy and literacy in primary and middle schools.

Condron and Rosogno (2003) analyzed unique within-district variations in spending and achievement among 89 public elementary schools in a large Ohio urban district. Their analyses revealed considerable disparities in spending within the district, which were linked to local patterns of racial and class stratification and concentration. They showed how these locally driven inequalities and their links to specific school resources had consequences for achievement in five distinct subject areas.

Pugh et al. (2011) examined the effects of school expenditures on school performance in England over the period 2003-07 during which per pupil expenditure increased rapidly. The researchers found a generally significant but small effect of expenditure on school performance, but the effect varied between specialist and non-specialist schools with the effect on the latter being larger.

Gigliotti and Sorenson (2018) found that achievement gains of approximately 0.047 standard deviations in math and 0.042 standard deviations in English corresponded to $1,000 in additional per-pupil spending, strengthening the case that school resources matter and that sustained financial investments can help districts maintain and improve quality of public education.

III. Data Sources

The primary source of data for this study was the New York State Education Department's Data Site for the 2018-2019 school year. Data on 94 school districts located in Nassau and Suffolk Counties, New York were included in this study. It should be noted that there are more than 94 school districts in this region. Several school districts were excluded for having unusually small populations of students. The researchers excluded school districts that had less than 100 students in either their high schools or their elementary schools. Also, not all of the school districts in this region were K - 12 school districts. The 94 school districts in this study only included K - 12 school districts because it was the researchers' intentions to measure student achievement through a variety of New York State student assessments that spanned elementary school, middle school, and high school.

The other major source of data for this study was based on each school district's reporting of their 2016 - 2019 technology plan: "Per Part 100.12 of Commissioner's Regulations, all New York State public school districts are required to develop and maintain instructional technology plans" (*New York State Education Department, 2018*).

IV. Method

The researchers sought to measure student achievement through a variety of variables across the school districts' grade levels and subject areas. These achievement variables included the following: (a) the percent of students receiving a New York State Regents Diploma with Advanced Designation (Advanced Regents Diploma) by school district; (b) the percent of students receiving a passing score on the New York State high school English Language Arts Regents Examination (ELA Regents Exam) by school district; (c) the percent of students receiving a passing score on the New York State high school Geometry Regents Examination (Geometry Regents Exam) by school district; (d) the percent of students obtaining Levels 3 to 4 on the New York State Grades 3 - 8 English Language Arts (ELA) examinations by school district; and (e) the percent of students obtaining Levels 3 to 4 on the New York State Grades 3 - 8 Mathematics (Math) examinations by school district (*New York State Education Department Data Site,* 2020).

The researchers measured technology by the amounts of technological devices available divided by the total student population by school district and stated as a percent. These devices typically included PCs, laptops, tablets, and Chromebooks. The variable which measured per pupil spending was the expenditures per pupil by school district that included federal, state, and local spending (*New York State Education Department Data Site*, 2020). A Pearson Product-Moment correlation analysis, with a two-tailed test of significance with alpha set at .05, was used to analyze the relationships between the variables.

V. Results

Table 1 illustrates the results for the correlations with the school district student achievement variables. The percent of devices by school district student population had a statistically significant and positive correlation with all of the variables used to measure student achievement, $p < .05$. The percent of devices had the strongest correlation with the percent of students achieving Level 3 or 4 on the grades 3-8 Mathematics assessments, accounting for 24.4 percent of the variance. As the percent of devices by student population increased, the percent of students achieving Level 3 or 4

achievement on the Mathematics assessments increased. The second strongest correlation among devices and student achievement was with the grades 3 - 8 ELA assessments, accounting for 19.01 percent of the variance.

Devices accounted for 17.47 percent of the variance on the percent of students graduating with a Regents Diploma with Advanced Designation. As devices increased, so did graduation rates. Devices had a statistically significant and positive correlation with the percent of students receiving passing scores on the high school Geometry Regents examinations, accounting for 14.29 percent of the variance. Devices similarly had a statistically significant and positive correlation with the percent of students receiving passing scores on the high school ELA Regents examinations, accounting for 11.29 percent of the variance.

The percent of devices by student population had a statistically significant and positive correlation with per pupil spending, $p < .05$. However, the correlation was weak, accounting for only 7.95 percent of the variance.

Similar to devices by school district student population, per pupil spending had a statistically significant and positive correlation with all of the variables used to measure student achievement, $p < .05$. As per pupil spending went up, student achievement went up. In rank order from strongest to weakest correlations were as follows: Per pupil sending

Table 1 *Correlations with School District Student Achievement Variables* (N = 94)

		Regents Diploma w/ Adv. Designation	HS ELA Regents Exam	HS Geometry Regents Exam	ELA Grades 3 - 8 Exams	Math Grades 3 - 8 Exams	Per Pupil Spending
HS ELA Regents Exam	r	0.811					
	r^2	65.77%					
	p	0.000					
	N	86					
HS Geometry Regents Exam	r	0.857	0.736				
	r^2	73.44%	54.17%				
	p	0.000	0.000				
	N	86	93				
ELA Grades 3-8 Exams	r	0.83	0.745	0.694			
	r^2	68.89%	55.50%	48.16%			
	p	0.000	0.000	0.000			
	N	86	94	93			
Math Grades 3-8 Exams	r	0.832	0.773	0.726	0.953		
	r^2	69.22%	59.75%	52.71%	90.82%		
	p	0.000	0.000	0.000	0.000		
	N	86	94	93	94		
Per Pupil Spending	r	0.425	0.349	0.393	0.468	0.455	
	r^2	18.06%	12.18%	15.44%	21.90%	20.70%	
	p	0.000	0.001	0.000	0.000	0.000	
	N	86	94	93	94	94	
Devices	r	0.418	0.336	0.378	0.436	0.494	0.282
	r^2	17.47%	11.29%	14.29%	19.01%	24.40%	7.95%
	p	0.002	0.009	0.003	0.001	0.000	0.031
	N	52	59	58	59	59	59

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

accounted for 21.9 percent of the variance on the grades 3 - 8 ELA assessments; 20.7 percent of the variance on the grades 3 - 8 Mathematics assessments; 18.06 percent of the variance on the percent of students graduating with a Regents Diploma with Advanced Designation; 15.44 percent of the variance on the percent of students receiving passing scores on the high school Geometry Regents examinations; and 12.18 percent of the variance on the high school ELA Regents examinations.

VI. Conclusions

The use of technology, as measured by the availability of devices by student population, had the greatest impact on student achievement at the elementary and middle school levels. Per pupil spending also had the greatest impact at these school levels. Technology spending was not a big driver of per pupil spending, as it only accounted for 7.95 percent of the variance on per pupil spending. School district leaders can leverage student achievement through the use of technology without significantly increasing per pupil spending in their school districts. There is a relatively strong correlation with the number of devices and achievement on the Mathematics assessments and English Language Arts assessments, grades 3 - 8. The implication here is that a one-time cost purchasing computers in K - 8 schools, had a multiplier effect on student achievement, accounting for over 24 and 19 percent of the variance respectively.

VII. Implications of the Research

Future studies should conduct a more detailed investigation on the various budgetary items that constitute per pupil spending. These studies should further probe how to increase student achievement without dramatically impacting per pupil spending. There needs to be more research on why devices had the greatest impact on student achievement for elementary and middle school-aged children. Perhaps teachers at those levels, who have less core content specific training than at the high school levels, are more reliant upon the use of technology and apps for their students. Or, perhaps there are more apps that are more aligned with the curriculum at these grade levels. In any event, future studies should examine the reasons for this trend.

This study was conducted prior to the COVID-19 crisis in education. There needs to be a post COVID-19 follow-up study to investigate the relationships between technology, spending, and district-wide student achievement. Technology spending during the COVID-19 crisis might have amplified or altered the relationships among the variables in this study. Finally, if the results of this study remain consistent with future studies, school districts should continue to make devices available to their student populations, particularly at the elementary and middle school levels, as a means to increase student achievement without significantly increasing spending.

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Craig Markson, Ed.D., is the Director of the Educational Leadership Program at Stony Brook University, Stony Brook, NY.

Kenneth Forman, Ph.D., is the Assistant Director of the Educational Leadership Program at Stony Brook University, Stony Brook, NY.