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The Impact of Teacher Technology Training on Student Technology Assessments

Preston A. Clark

Central Michigan University, USA

Mingyuan Zhang[1]

Central Michigan University, USA

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Abstract: The purpose of this study was to examine the connections that may exist between the student technology literacy performance in the national schools and teachers who have had technology-focused professional development. Utilizing the online NAEP data, the study examined two school-reported variables related to teacher technology-specific professional development and student TEL scores on a national level. The results presented here suggest that teachers with training in technology usage may be more successful with students than those without. This study may provide insight into understanding more about the relevance of teacher training with regards to technology

Keywords: *Assessment of Student Technology; Data Mining; NAEP; National Data; Professional Development.*

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Introduction

An ongoing debate exists within the field of education. There is a belief that the more skilled and credentialed an educator is, the better the quality of instruction. However, an equal and opposite viewpoint exists that it is not the credentialing of the teacher that ensures quality instruction, but the experience a teacher has at teaching the content that ensures that learning can be achieved regardless of where a teacher

[1] **Corresponding author:** Mingyuan Zhang
Email: zhang1m@cmich.edu

gets trained in the content. In this age of technology, it is critical that students can grasp the technological concepts in a world that is ever more dependent on the myriad of devices a student uses today.

In recent years, the demand for incorporating technology into the K-12 environment has been increasing. To meet this demand, teachers are becoming required to have professional development, certification, or a degree in using technology within their classrooms with the belief that having these skills will enhance the success of student comprehension of technology. This demand is perceived to be no different from any other required credentialing for math, reading, or the sciences. One would expect that if a teacher comes with a high level of training or experience in an area, then this would imply that there would be equally high comprehension success for students of those teachers. This led to many states setting professional development (PD) and certification standards (Darling-Hammond, 2000).

However, stemming from the expectation that a teacher's qualifications would distinguish the ability of that teacher from other teachers, there is conflict in the literature as to the accuracy of such a claim. The purpose of this study is to examine the connections between 8th-grade NAEP Technology and Engineering Literacy (TEL) score performance in public/non-public schools and teacher level of technology professional development.

The question of teacher qualifications and credentialing became paramount with the enactment of the "No Child Left Behind" Act of 2001 (Buddin & Zamarro, 2009). It was believed that teachers with a high degree of professional development or a higher degree in education would ensure quality instruction occurred in the classroom (Tess, 2013). Researchers challenged this premise and found that there was an effect for some content but not for all content (Boonen, Van Damme, & Onghena, 2014; Harris & Sass, 2011; Kane, Rockoff, & Staiger, 2008). Content such as math that requires particular method skills seem to support teachers who are trained in math practices. Teachers who have learned through experience how to motivate and involve students in learning seem most effective in reading, for example. The search for a definitive explanation continues. However, stemming from the expectation that a teacher's qualifications would distinguish the ability of that teacher from other teachers, there is conflict in the literature as to the accuracy of such a claim. One may conclude from this dichotomy that there exists a need to identify what content is best taught by teachers with specific credentialing or whether teaching experience is best. It may be necessary to address the question of qualifications or experience for each content area.

Whether it is credentialing, experience, or both, when it comes to technology instruction, it is crucial in the digital information age that students learn to be proficient with the hardware and software they will use every day. Elementary and secondary education faces the challenge to provide instruction in technology. Currently, there appears to be limited research on how a teacher's qualifications may impact student technology achievement, approached the issue from a student engagement and teacher effectiveness perspective. Some studies identify establishing technology environments that encourage learning which allow teachers to have the technologies at hand for more accessible learning opportunities (Gebre, Saroyan, & Bracewell, 2014) or by providing specific teacher interventions or professional development (Gibson et al., 2014; Wang, Hsu, Reeves, & Coster, 2014). Unfortunately, neither of these approaches addresses what will work best for the students and what approach for teacher training – technology teaching experience or specific technology training qualifications – are the best approach to ensuring that students are successful in technology use.

The findings from this study could provide valuable insight for school administrations by helping to determine whether teacher technology qualifications or technology teaching experience are critical to ensuring the quality teaching of technology to students.

The following are the research questions that this study addressed using the NAEP dataset examining the 2014 8th grade TEL scores and teacher qualifications subset:

Are TEL scores of 8th-grade students higher for schools whose teachers have had technology and engineering training than of students of schools where teachers have less training in technology and engineering?

Are TEL scores of public school students greater than those of non-public school students where schools with teachers who have had training in technology and engineering?

Our theoretical framework for this research adopts a scientific inquiry-based approach. The framework was described in great details in The Impact of Conversations on Fourth Grade Reading Performance - What NAEP Data Explorer Tells? (Bond & Zhang, 2017). In summary, the research methods combined the inquiry process with scientific knowledge, reasoning, and critical thinking. We started with an extensive exploration of the dataset and that led to the designing of the research questions. The research questions further guided us to mine the data with great in-depth.

Literature Review

In recent years, the demand for incorporating technology into the K-12 environment has been increasing in demand. To meet this demand, teachers are becoming required to incorporate and teach technology skills into their lesson plans. Some schools have required professional development, certification, or a degree in using technology within their classrooms with the belief that having these skills will enhance the success of student comprehension of technology. This demand is perceived to be no different from any other required credentialing for math, reading, or the sciences. This approach expects that a teacher with a high level of training or experience in a content area implies that the students they teach will display greater comprehension of the subject than students whose teachers do not have such credentials.

However, stemming from the expectation that a teacher's qualifications or experience would distinguish the ability of that teacher from other teachers, there is conflict in the literature as to the accuracy of such a claim. Over the past decade or so, this anecdotal observation has been explored with some interesting findings.

Teacher Qualifications and Impact on Student Success

Teacher qualifications became a significant concern following the passing of the No Child Left Behind Act (NCLB) as a law in 2002. The law required that teachers in K-12 should have credentials that support their ability to teach specific content material such as reading, math, and the sciences. Since that time, researchers have examined the impact of teacher qualifications on student achievement. The result of the law caused states to set qualification policies requiring K-12 teachers to have or obtain credentials to continue teaching the key content. Darling-Hammond (2000) looked at how state policy requirements for teacher qualifications will influence the level of capability a teacher will apply to their teaching and would impact student learning.

In examining the scope of research on teacher qualifications and its relationship to student success during the period just prior to NCLB, Wayne and Youngs (2003) performed a meta-analysis of 21 studies addressing this topic. They found that studies confirmed that students learn more from teachers who have specific teacher characteristics. Those characteristics centered around "teachers' college ratings and test scores" (p. 107). It was noted that further investigation was necessary to determine just how critical such ratings and scores were as some subject areas were inconclusive in the study except for mathematics where it was clear that students performed better when teachers had degrees or college courses related to mathematics. More recently, other researchers (Boonen et al., 2014) have since agreed that teachers who are trained in mathematics are better prepared to teach mathematics and there is a higher effect on student performance in math where those teachers experienced in reading and spelling also display higher levels of success regardless of degree or credentialing.

Qualifications vs. Experience - Mixed Results

While studies indicate a relationship between student success and teachers exist, there is a discrepancy in how much of an impact a teacher has; whether it is teacher qualifications or teaching experience that influences student success; and whether the subject matter is affected by either a teacher's qualifications, experience or both.

Some researchers found evidence suggesting that a teacher with high qualifications such as a degree, certification, or hours of professional development on a subject can increase student achievement in some subjects such as math and science (Boonen et al., 2014) where it is crucial to learn specific approaches to be successful with the content. In a study of North Carolina public school teachers, Henry et al. (2014) explored the formal preparation and qualifications of new teachers. They found that in-state public universities undergraduate-prepared teachers were more effective than out-of-state or alternative entry teachers. Teach for America corps teachers were more effective in the STEM subjects than teachers trained at in-state public universities. Still, other investigations (Goldhaber, Liddle, & Theobald, 2013; Kane et al., 2008) contend that teacher experience and not a teacher’s qualifications is critical to ensure learning success.

As research continued to center on the issue of student achievement and teacher ability, a schism began to form. Some researchers found that teacher qualifications alone had little to no impact on student achievement (Buddin & Zamarro, 2009; Palardy & Rumberger, 2008). However, in some content areas such as math, but in other areas, teaching experience, particularly within the first 5 years of in-service teaching saw significant increases in achievement, particularly in areas such as reading and spelling. Some researchers believe this is due to the type of instruction teachers gained in their degree programs, certification, and PD. In areas, such as Math and Reading, for example, it has been suggested that teachers who learned math mechanics passed it on to students. In reading, a teacher most often learns approaches to teaching students how to read and so tend to be more successful. It seems that within the literature a dilemma exists as to how a teacher’s knowledge of a subject and how they were trained impacts student achievement. The results are still unclear though there seems to be some indication that this topic requires additional exploration.

Teacher Technology Credentials and Experience and Student Success

When it comes to teacher influence on student learning technology, there seems to be limited research on how a teacher's qualifications and expertise may impact student technology achievement. Gebre et al. (2014) approached the issue from a student engagement and teacher effectiveness perspective. Teachers were using specifically designed technology-rich classrooms where teachers were highly skilled in the use of the classroom. Though this study was implemented in a higher education environment, it suggests that providing an environment such as this and providing support for the teacher will ensure higher cognitive learning results in students.

Unfortunately, there continues to be confusion within this area of study and limited research in how teacher qualifications and experience impact student achievement with regards to technology. This study of NAEP data and the recently collected data on 8th grade TEL scores can add to the knowledge of the field by further examining the impact of a teacher who is formally technologically trained and compare these results to similar studies. The methods section will provide the approach used in this study.

Research Methods

What is NAEP?

The National Assessment of Educational Progress (NAEP) which is also known as The Nation's Report Card provides a national report on the academic achievements of elementary and secondary students. Since 1980, NAEP has assessed achievement by nationally testing sample students in the 4th, 8th, and 12th grades. These data results have become the primary source of how students perform in 10 subject areas including math, reading, writing, and science. Added to the collection of subjects is a recent assessment based on a "framework of technological literacy" by the National Assessment Governing Board (NAGB, 2014). The subsequent dataset was first used in 2014 with 8th graders. Future assessments are planned for the 4th and 12th grade. This study utilized this first dataset in its analyses.

NAEP Participants and Sampling

In 2014, the National Center for Education Statistics (NCES) was given the Technology and Engineering Literacy (TEL) framework that provides the "…theoretical basis for assessment and describes the types of questions…" and how they would be incorporated into a questionnaire that was conducted during that same year (NCES, 2016).

The participants were a random sample of 21,500 eighth-grade students from approximately 840 schools across the country who took the TEL assessment. ("About the tel assessment," 2014). Additionally, the following is known about the assessment measures (NCES, 2016). The TEL assessment is designed to measure three interconnected areas of technology and engineering literacy:

Technology and Society involve the effects that technology has on society and on the natural world and the ethical questions that arise from those effects. Design and Systems cover the nature of technology, the engineering design process by which technologies are developed, and basic principles of dealing with everyday technologies, including maintenance and troubleshooting. Information and Communication Technology includes computers and software learning tools, networking systems and protocols, hand-held digital devices, and other technologies for accessing, creating, and communicating information and for facilitating creative expression.

Data Analysis

The online NAEP Data Explorer analysis tool allowed for a descriptive analysis of the assessment data. According to NCES (n.d.). The Data Explorer for Main NAEP provides national and state results in 10 subject areas, including mathematics, reading, writing, and science. Results have been produced for the nation and participating states and other jurisdictions since 1990, and for selected urban districts (on a trial basis) since 2002.

The use of the Data Explorer provided the means to obtain the data of the TEL variables needed for this study and provided the analysis tools to conduct the analysis. This study used descriptive analysis methods. While this study cannot address causal relationships, it is hoped that some insight into the data will be useful in future studies. For determining Effect Size, Cohen's d effect sizes (Cohen, 1988) were calculated by using an online effect size calculator (http://www.uccs.edu/~lbecker/) (Becker, 2016a). Cohen's d effect size refers to those indices that measure the magnitude of a treatment outcome. It is independent of sample size and therefore is unaffected by situations that can hamper a measure such as can occur with significance tests (Becker, 2016b).

Variable Selection

The TEL data used in this study identified the TEL proficiency scores and questionnaire items in the following areas: Jurisdiction includes national schools, national public schools, and national private schools; the measures include the Overall Technology and Engineering Literacy (TEL) scale. The two variables are (1) Percent in professional development in integrating information technology into instruction and (2) Percent in professional development in technology or technological literacy.

Results

As the NAEP Data Explorer does not include direct numbers for each table, we were only able to utilize the summary means and standard deviations provided to perform statistical analyses. Therefore, no frequency tables could be generated. Percentages of the sample for each variable level was obtainable and was included in tables where appropriate. From the data generated by the NAEP Data Explorer, the following tables were created. The average overall TEL assessment score was 150 (scale range 0-300) with a standard deviation of 35 ("Overall results," 2014). Differences in scores by questions are shown in the tables in this section.

The following tables and figures do not include the assessment response data for “Not applicable” or “I don’t know” in this study and therefore removed where possible by the Data Explorer.

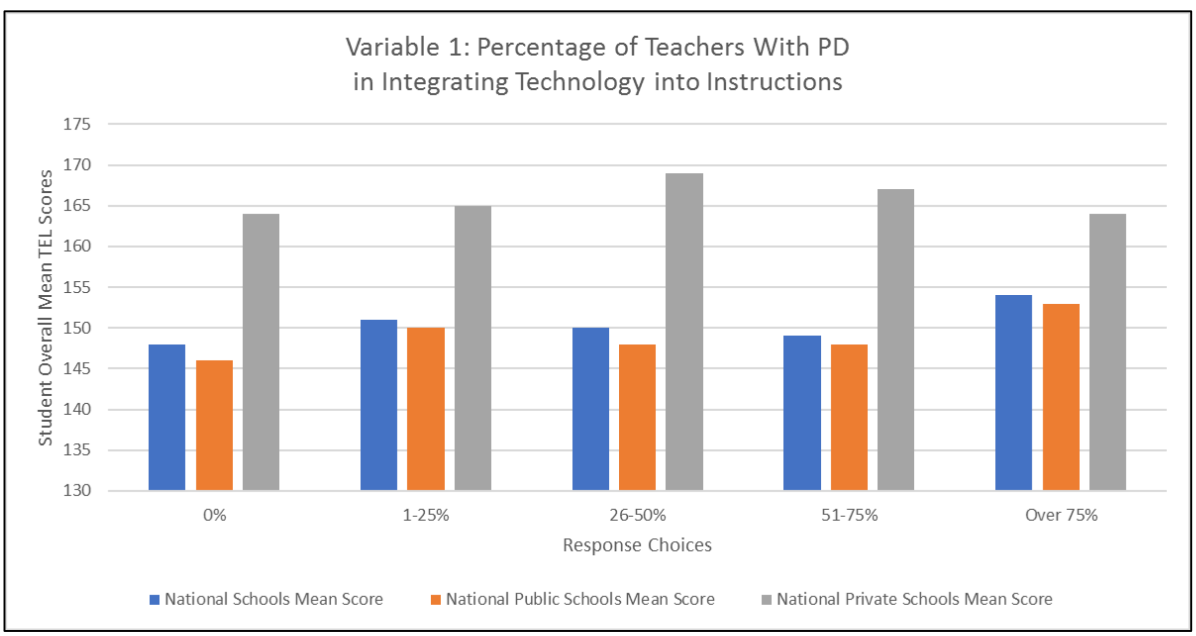

Figure 1. Percentage of Teachers with PD Integration and Student Mean TEL Scores

Figure 1 and Table 1. In the past two years, what percentage of teachers in your school has participated in professional development in integrating information and communications technology into instruction? (school-reported) [C094503]

Table 1.

Average Scale Scores and Standard Deviations for National Schools, National Public Schools, and National Private Schools

Variable Levels	National Schools			National Public Schools			National Private Schools		
	Mean Score	SD	%	Mean Score	SD	%	Mean Score	SD	%
0%	148	34	8%	146	34	8%	164	33	9%
1-25%	151	34	39%	150	34	39%	165	32	32%
26-50%	150	35	11%	148	36	10%	169	29	20%
51-75%	149	35	9%	148	35	9%	167	30	8%
Over 75%	154	35	26%	153	35	26%	164	30	23%

Figure 1 and Table 1 represent the average overall TEL scale scores of eighth-grade students with reference to the percentage of schools that had teachers who received training in integrating information technology into instruction within the past two years.

Table 2.

Differences Between Jurisdictions at "0%"

Technology and Engineering Literacy, grade 8, Difference in average scale scores between jurisdictions, for percent in professional development in integrating information technology into instruction [C094503] = 0%2014

	National(148)	National public(146)	National private(164)
National(148)		> Diff = 2 P-value = 0.0499 Family size = 2	< Diff = -16 P-value = 0.0000 Family size = 2
National public(146)	< Diff = -2 P-value = 0.0499 Family size = 2		< Diff = -17 P-value = 0.0000
National private(164)	> Diff = 16 P-value = 0.0000 Family size = 2	> Diff = 17 P-value = 0.0000	

LEGEND:

<	Significantly lower.
>	Significantly higher.
x	No significant difference.

NOTE: Within country comparisons on any given year are dependent with an alpha level of 0.05.

Table 2 shows the results of multiple t-tests created by Data Explorer and presents the mean differences and results between the jurisdictions for the variable level "0%" addressing the percent of teachers in professional development in integrating information technology into instruction. Data Explorer analyses have an alpha set of 0.05 as explained by Klecker and Klecker (2014, p. 12) The average TEL scores of students (8%) in the national jurisdiction (M=148, SD=34) where schools had "0%" teachers trained was significantly ($p<0.05$) higher than the average scale scores of students (8%) in the public jurisdiction (M=146, SD=34).

Table 3.

Differences Between Jurisdictions at "1-25%"

Technology and Engineering Literacy, grade 8, Difference in average scale scores between jurisdictions, for percent in professional development in integrating information technology into instruction [C094503] = 1-25%2014

	National(151)	National public(150)	National private(165)
National(151)		> Diff = 1 P-value = 0.0344 Family size = 2	< Diff = -14 P-value = 0.0291 Family size = 2
National public(150)	< Diff = -1 P-value = 0.0344 Family size = 2		< Diff = -14 P-value = 0.0285
National private(165)	> Diff = 14 P-value = 0.0291 Family size = 2	> Diff = 14 P-value = 0.0285	
LEGEND:			
<	Significantly lower.		
>	Significantly higher.		
x	No significant difference.		

NOTE: Within country comparisons on any given year are dependent with an alpha level of 0.05.

The average TEL scores of students (9%) in the private jurisdiction (M=164, SD=33) where schools had "0%" teachers trained was significantly ($p<0.001$) higher than the average scale scores of students (8% each respectively) in the national and public jurisdictions (148, SD=34; M=146, SD=34 respectively). The average TEL scores of students in the private jurisdiction were 16 and 17 points higher than average student scores in the national and public jurisdictions respectively.

Table 3 shows the results of multiple t-tests and presents the mean differences and results between the jurisdictions for the variable level “1-25%” addressing the percent of teachers in professional development in integrating information technology into instruction. The average TEL scores of students (39%) in the national jurisdiction (M=151, SD=34) where schools had “1-25%” teachers trained was significantly ($p<0.05$) higher than the average scale scores of students (39%) in the public jurisdiction (M=150, SD=34).

The average TEL scores of students (32%) in the private jurisdiction (M=165, SD=32) where schools had “1-25%” teachers trained was significantly ($p<0.05$) higher than the average scale scores of students (39% each respectively) in the national and public jurisdictions (M=151, SD=34; M=150, SD=34 respectively). The average TEL scores of students in the private jurisdiction were 14 points higher than average student scores in the national and public jurisdictions.

Table 4 shows the results of multiple t-tests and presents the mean differences and results between the jurisdictions for the variable level “26-50%” addressing the percent of teachers in professional development in integrating information technology into instruction. The average TEL scores of students (11%) in the national jurisdiction (M=150, SD=35) where schools had “26-50%” teachers trained was significantly ($p<0.001$) higher than the average scale scores of students (10%) in the public jurisdiction (M=150, SD=34).

Table 4.

Differences Between Jurisdictions at "26-50%"

Technology and Engineering Literacy, grade 8, Difference in average scale scores between jurisdictions, for percent in professional development in integrating information technology into instruction [C094503] = 26-50%2014

	National(150)	National public(148)	National private(169)
National(150)		> Diff = 3 P-value = 0.0005 Family size = 2	< Diff = -18 P-value = 0.0000 Family size = 2
National public(148)	< Diff = -3 P-value = 0.0005 Family size = 2		< Diff = -21 P-value = 0.0000
National private(169)	> Diff = 18 P-value = 0.0000 Family size = 2	> Diff = 21 P-value = 0.0000	

LEGEND:

<	Significantly lower.
>	Significantly higher.
x	No significant difference.

NOTE: Within country comparisons on any given year are dependent with an alpha level of 0.05.

The average TEL scores of students (20%) in the private jurisdiction (M=165, SD=32) where schools had "26-50%" teachers trained was significantly ($p<0.001$) higher than the average scale scores of students (11% and 10% respectively) in the national and public jurisdictions (M=150, SD=35; M=148,

SD=36 respectively). The average TEL scores of students in the private jurisdiction were 14 and 21 points higher than average student scores in the national and public jurisdictions respectively.

Table 5.

Differences Between Jurisdictions at "51-75%"

Technology and Engineering Literacy, grade 8, Difference in average scale scores between jurisdictions, for percent in professional development in integrating information technology into instruction [C094503] = 51-75%2014

	National(149)	National public(148)	National private(167)
National(149)		x Diff = 1 P-value = 0.1396 Family size = 2	< Diff = -18 P-value = 0.0000 Family size = 2
National public(148)	x Diff = -1 P-value = 0.1396 Family size = 2		< Diff = -19 P-value = 0.0000
National private(167)	> Diff = 18 P-value = 0.0000 Family size = 2	> Diff = 19 P-value = 0.0000	

LEGEND:

<	Significantly lower.
>	Significantly higher.
x	No significant difference.

NOTE: Within country comparisons on any given year are dependent with an alpha level of 0.05.

Table 5 shows the results of multiple t-tests and presents the mean differences and results between the jurisdictions for the variable level "51-75%" addressing the percent of teachers in professional development in integrating information technology into instruction. The average TEL scores of students (9%) in the national jurisdiction (M=149, SD=35) where schools had "51-75%" teachers trained showed no significant difference ($p>0.05$) between the average scale scores of students (9%) in the public jurisdiction (M=148, SD=35).

The average TEL scores of students (8%) in the private jurisdiction (M=167, SD=30) where schools had “51-75%” teachers trained was significantly ($p<0.001$) higher than the average scale scores of students (9% each respectively) in the national and public jurisdictions (M=149, SD=35; M=148, SD=35 respectively). The average TEL scores of students in the private jurisdiction were 18 and 19 points higher than average student scores in the national and public jurisdictions respectively.

Table 6.

Differences Between Jurisdictions at “Over 75%”

Technology and Engineering Literacy, grade 8, Difference in average scale scores between jurisdictions, for percent in professional development in integrating information technology into instruction [C094503] = Over 75%2014			
	National(154)	National public(153)	National private(164)
National(154)		> Diff = 1 P-value = 0.0467 Family size = 2	< Diff = -10 P-value = 0.0087 Family size = 2
National public(153)	< Diff = -1 P-value = 0.0467 Family size = 2		< Diff = -11 P-value = 0.0086
National private(164)	> Diff = 10 P-value = 0.0087 Family size = 2	> Diff = 11 P-value = 0.0086	
LEGEND:			
<	Significantly lower.		
>	Significantly higher.		
x	No significant difference.		
NOTE: Within country comparisons on any given year are dependent with an alpha level of 0.05.			

Table 6 shows the results of multiple t-tests and presents the mean differences and results between the jurisdictions for the variable level "Over 75%" addressing the percent of teachers in professional development in integrating information technology into instruction. The average TEL scores of students (26%) in the national jurisdiction (M=154, SD=35) where schools had "Over 75%" teachers trained was significantly ($p<0.05$) higher than the average scale scores of students (26%) in the public jurisdiction (M=153, SD=35).

Table 7.

Effect Size of Differences in Scores Between National and Public Jurisdiction

	Jurisdictions	Cohen's *d* Effect Size	Result
0%	National / Public	$d = 0.06$	Trivial
1-25%	National / Public	$d = 0.03$	Trivial
26-50%	National / Public	$d = 0.06$	Trivial
51-75%	National / Public	$d = 0.03$	Trivial
Over 75%	National / Public	$d = 0.03$	Trivial

Cohen's d Effect Size determined using Effect Size calculator (Becker, 2016a)

The average TEL scores of students (23%) in the private jurisdiction (M=164, SD=30) where schools had "Over 75%" teachers trained was significantly ($p<0.01$) higher than the average scale scores of students (11% and 10% respectively) in the national and public jurisdictions (M=154, SD=35; M=153,

SD=35 respectively). The average TEL scores of students in the private jurisdiction were 10 and 11 points higher than average student scores in the national and public jurisdictions respectively.

Table 7 shows the effect sizes of the difference between the mean average TEL student scores in the national and public jurisdictions. In this table, all effect sizes were trivial (between 0.03 and 0.06).

Table 8.

Effect Size of Differences in Scores Between National and Private Jurisdiction

	Jurisdictions	Cohen's *d* Effect Size	Result
0%	National / Private	*d* = 0.48	Small
1-25%	National / Private	*d* = 0.42	Small
26-50%	National / Private	*d* = 0.59	Medium
51-75%	National / Private	*d* = 0.55	Medium
Over 75%	National / Private	*d* = 0.31	Small

Cohen's d Effect Size determined using Effect Size calculator (Becker, 2016a)

Table 8 shows the effect sizes of the difference between the mean average TEL student scores in the national and private jurisdictions. In this table, effect sizes for small (d = 0.48) for "0%", small (d =

0.42) for “1-25%”, medium (d = 0.59) for “26-50%”, medium (d = 0.55) for “51-75%” and small (0.31) for “Over 75%”.

Table 9.

Effect Size of Differences in Scores Between Public and Private Jurisdiction

	Jurisdictions	Cohen’s *d* Effect Size	Result
0%	Public / Private	*d* = 0.54	Medium
1-25%	Public / Private	*d* = 0.45	Small
26-50%	Public / Private	*d* = 0.64	Medium
51-75%	Public / Private	*d* = 0.58	Medium
Over 75%	Public / Private	*d* = 0.34	Small

Cohen’s d Effect Size determined using Effect Size calculator (Becker, 2016a)

Table 9 shows the effect sizes of the difference between the mean average TEL student scores in the public and private jurisdictions. In this table, effect sizes for medium (d = 0.54) for “0%”, small (.d = 0.45) for “1-25%”, medium (d = 0.64) for “26-50%”, medium (d = 0.58) for “51-75%” and small (d=0.34) for “Over 75%”.

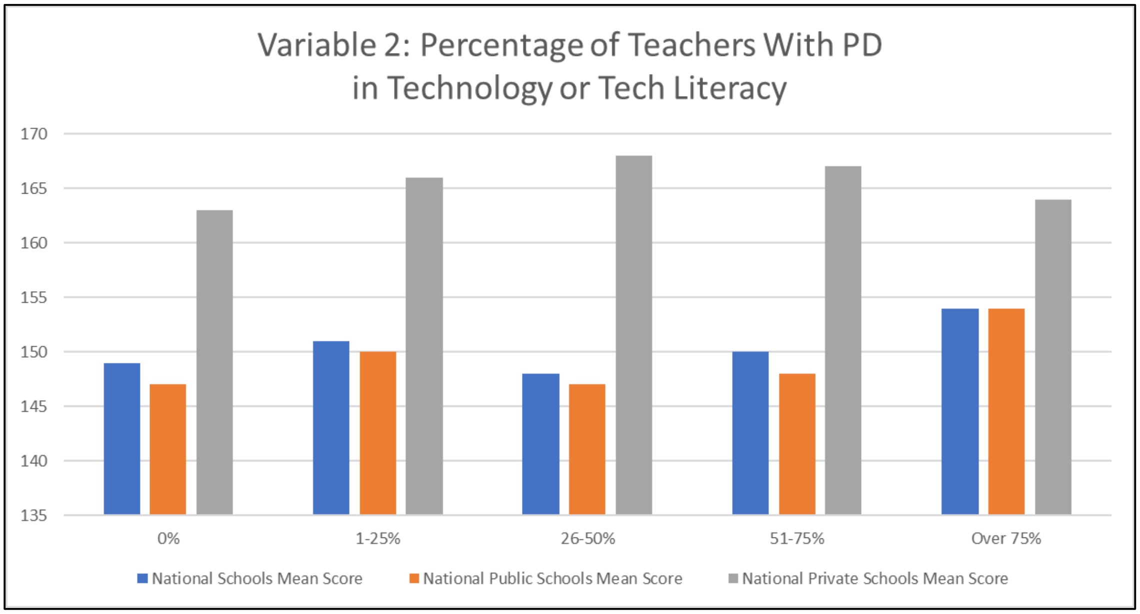

Figure 2. Percentage of Teachers with PD Technology & Tech Literacy and Student Mean TEL Scores

Figure 2 & Table 4. In the past two years, what percentage of teachers in your school has participated in professional development in content, curriculum, or pedagogy related to technology or technological literacy? (school-reported). [C094502]

Figure 2 and Table 10 represent the average overall TEL scale scores of eighth-grade students with reference to the percentage of schools that had teachers who received training in technology or technological literacy within the past two years.

Table 10.

Average Scale Scores and Standard Deviations for National Schools, National Public Schools, and National Private Schools

Variable Levels	National Schools			National Public Schools			National Private Schools		
	Mean Score	SD	%*	Mean Score	SD	%	Mean Score	SD	%
0%	149	34	9%	147	34	8%	163	31	12%
1-25%	151	35	47%	150	35	47%	166	32	39%
26-50%	148	36	10%	147	35	10%	168	31	10%
51-75%	150	34	5%	148	34	5%	167	29	7%
Over 75%	154	34	21%	154	34	21%	164	30	23%

Table 11 shows the results of multiple t-tests created by Data Explorer and presents the mean differences and results between the jurisdictions for the variable level “0%” addressing the percent of teachers in professional development in technology or technological literacy. The average TEL scores of students (9%) in the national jurisdiction (M=149, SD=34) where schools had “0%” teachers trained was significantly ($p<0.05$) higher than the average scale scores of students (8%) in the public jurisdiction (M=147, SD=34).

Table 11.

Differences Between Jurisdictions at "0%"

Technology and Engineering Literacy, grade 8, Difference in average scale scores between jurisdictions, for percent in professional development in technology or technological literacy [C094502] = 0%2014

	National(149)	National public(147)	National private(163)
National(149)		> Diff = 2 P-value = 0.0029 Family size = 2	< Diff = -14 P-value = 0.0000 Family size = 2
National public(147)	< Diff = -2 P-value = 0.0029 Family size = 2		< Diff = -15 P-value = 0.0000
National private(163)	> Diff = 14 P-value = 0.0000 Family size = 2	> Diff = 15 P-value = 0.0000	
LEGEND:			
<	Significantly lower.		
>	Significantly higher.		
x	No significant difference.		
NOTE: Within country comparisons on any given year are dependent with an alpha level of 0.05.			

The average TEL scores of students (12%) in the private jurisdiction (M=163, SD=31) where schools had "0%" teachers trained was significantly ($p<0.001$) higher than the average scale scores of students (8% each respectively) in the national and public jurisdictions (M=149, SD=34; M=147, SD=34 respectively). The average TEL scores of students in the private jurisdiction were 14 and 15 points higher than average student scores in the national and public jurisdictions respectively.

Table 12.

Differences Between Jurisdictions at "1-25%"

Technology and Engineering Literacy, grade 8, Difference in average scale scores between jurisdictions, for percent in professional development in technology or technological literacy [C094502] = 1-25%2014

	National(151)	National public(150)	National private(166)
National(151)		> Diff = 1 P-value = 0.0004 Family size = 2	< Diff = -15 P-value = 0.0060 Family size = 2
National public(150)	< Diff = -1 P-value = 0.0004 Family size = 2		< Diff = -16 P-value = 0.0060
National private(166)	> Diff = 15 P-value = 0.0060 Family size = 2	> Diff = 16 P-value = 0.0060	
LEGEND:			
<	Significantly lower.		
>	Significantly higher.		
x	No significant difference.		
NOTE: Within country comparisons on any given year are dependent with an alpha level of 0.05.			

Table 12 shows the results of multiple t-tests and presents the mean differences and results between the jurisdictions for the variable level "1-25%" addressing the percent of teachers in professional development in technology or technological literacy. The average TEL scores of students (47%) in the national jurisdiction (M=151, SD=35) where schools had "1-25%" teachers trained was significantly (p<0.001) higher than the average scale scores of students (47%) in the public jurisdiction (M=150, SD=35).

The average TEL scores of students (39%) in the private jurisdiction (M=166, SD=32) where schools had "1-25%" teachers trained was significantly ($p<0.01$) higher than the average scale scores of students (11% and 10% respectively) in the national and public jurisdictions (M=151, SD=35; M=150, SD=35 respectively). The average TEL scores of students in the private jurisdiction were 15 and 16 points higher than average student scores in the national and public jurisdictions respectively.

Table 13

Differences Between Jurisdictions at "26-50%"

Technology and Engineering Literacy, grade 8, Difference in average scale scores between jurisdictions, for percent in professional development in technology or technological literacy [C094502] = 26-50%2014

	National(148)	National public(147)	National private(168)
National(148)		> Diff = 2 P-value = 0.0180 Family size = 2	< Diff = -20 P-value = 0.0045 Family size = 2
National public(147)	< Diff = -2 P-value = 0.0180 Family size = 2		< Diff = -21 P-value = 0.0044
National private(168)	> Diff = 20 P-value = 0.0045 Family size = 2	> Diff = 21 P-value = 0.0044	

LEGEND:

<	Significantly lower.
>	Significantly higher.
x	No significant difference.

NOTE: Within country comparisons on any given year are dependent with an alpha level of 0.05.

Table 13 shows the results of multiple t-tests and presents the mean differences and results between the jurisdictions for the variable level "26-50%" addressing the percent of teachers in professional development in technology or technological literacy. The average TEL scores of students (10%) in the national jurisdiction (M=148, SD=36) where schools had "26-50%" teachers trained was significantly (p<0.05) higher than the average scale scores of students (10%) in the public jurisdiction (M=147, SD=35).

Table 14.

Differences Between Jurisdictions at "51-75%"

Technology and Engineering Literacy, grade 8, Difference in average scale scores between jurisdictions, for percent in professional development in technology or technological literacy [C094502] = 51-75%2014

	National(150)	National public(148)	National private(167)
National(150)		x Diff = 2 P-value = 0.1033 Family size = 2	< Diff = -16 P-value = 0.0006 Family size = 2
National public(148)	x Diff = -2 P-value = 0.1033 Family size = 2		< Diff = -19 P-value = 0.0004
National private(167)	> Diff = 16 P-value = 0.0006 Family size = 2	> Diff = 19 P-value = 0.0004	

LEGEND:

<	Significantly lower.
>	Significantly higher.
x	No significant difference.

NOTE: Within country comparisons on any given year are dependent with an alpha level of 0.05.

The average TEL scores of students (10%) in the private jurisdiction (M=168, SD=31) where schools had "26-50%" teachers trained was significantly (p<0.01) higher than the average scale scores of students (11% and 10% respectively) in the national and public jurisdictions (M=148, SD=36; M=147,

SD=35 respectively). The average TEL scores of students in the private jurisdiction were 20 and 21 points higher than average student scores in the national and public jurisdictions respectively.

Table 14 shows the results of multiple t-tests and presents the mean differences and results between the jurisdictions for the variable level "51-75%" addressing the percent of teachers in professional development in technology or technological literacy. The average TEL scores of students (5%) in the national jurisdiction (M=150, SD=34) where schools had "51-75%" teachers trained w showed no significant difference ($p>0.05$) between the average scale scores of students (5%) in the public jurisdiction (M=148, SD=34).

The average TEL scores of students (7%) in the private jurisdiction (M=167, SD=29) where schools had "51-75%" teachers trained was significantly ($p<0.01$) higher than the average scale scores of students (5% each respectively) in the national and public jurisdictions (M=150, SD=34; M=148, SD=34 respectively). The average TEL scores of students in the private jurisdiction were 16 and 19 points higher than average student scores in the national and public jurisdictions respectively.

Table 15 shows the results of multiple t-tests and presents the mean differences and results between the jurisdictions for the variable level "Over 75%" addressing the percent of teachers in professional development in technology or technological literacy. The average TEL scores of students (21%) in the national jurisdiction (M=154, SD=34) where schools had "Over 75%" teachers trained was significantly ($p<0.01$) higher than the average scale scores of students (21%) in the public jurisdiction (M=154, SD=34).

Table 15.

Differences Between Jurisdictions at "Over 75%"

Technology and Engineering Literacy, grade 8, Difference in average scale scores between jurisdictions, for percent in professional development in technology or technological literacy [C094502] = Over 75%2014

	National(154)	National public(154)	National private(164)
National(154)		> Diff = 1 P-value = 0.0012 Family size = 2	< Diff = -10 P-value = 0.0126 Family size = 2
National public(154)	< Diff = -1 P-value = 0.0012 Family size = 2		< Diff = -11 P-value = 0.0120
National private(164)	> Diff = 10 P-value = 0.0126 Family size = 2	> Diff = 11 P-value = 0.0120	

LEGEND:

<	Significantly lower.
>	Significantly higher.
x	No significant difference.

NOTE: Within country comparisons on any given year are dependent with an alpha level of 0.05.

The average TEL scores of students (23%) in the private jurisdiction (M=164, SD=30) where schools had "Over 75%" teachers trained was significantly ($p<0.05$) higher than the average scale scores of students (21% each respectively) in the national and public jurisdictions (M=154, SD=34; M=154, SD=34 respectively). The average TEL scores of students in the private jurisdiction were 10 and 11 points higher than average student scores in the national and public jurisdictions respectively.

Table 16.

Effect Size of Differences in Scores Between National and Public Jurisdiction

	Jurisdictions	Cohen's *d* Effect Size	Result
0%	National / Public	*d* = 0.06	Trivial
1-25%	National / Public	*d* = 0.03	Trivial
26-50%	National / Public	*d* = 0.03	Trivial
51-75%	National / Public	*d* = 0.06	Trivial
Over 75%	National / Public	*d* = 0.00	Trivial

Table 16 shows the effect sizes of the difference between the mean average TEL student scores in the national and public jurisdictions. In this table, all effect sizes were trivial (between 0.03 and 0.06).

Table 17 shows the effect sizes of the difference between the mean average TEL student scores in the national and private jurisdictions. In this table, effect sizes for small (d = 0.43) for "0%", small (d = 0.45) for "1-25%", medium (d = 0.60) for "26-50%", medium (d = 0.54) for "51-75%" and small (0.31) for "Over 75%".

Table 17.

Effect Size of Differences in Scores Between National and Private Jurisdiction

	Jurisdictions	Cohen's *d* Effect Size	Result
0%	National / Private	*d* = 0.43	Small
1-25%	National / Private	*d* = 0.45	Small
26-50%	National / Private	*d* = 0.60	Medium
51-75%	National / Private	*d* = 0.54	Medium
Over 75%	National / Private	*d* = 0.31	Small

Table 18 shows the effect sizes of the difference between the mean average TEL student scores in the public and private jurisdictions. In this table, effect sizes for small (d = 0.49) for "0%", small (d = 0.48) for "1-25%", medium (d = 0.64) for "26-50%", medium (d = 0.60) for "51-75%" and small (d=0.31) for "Over 75%".

Table 18.

Effect Size of Differences in Scores Between Public and Private Jurisdiction

	Jurisdictions	Cohen's *d* Effect Size	Result
0%	Public / Private	*d* = 0.49	Small
1-25%	Public / Private	*d* = 0.48	Small
26-50%	Public / Private	*d* = 0.64	Medium
51-75%	Public / Private	*d* = 0.60	Medium
Over 75%	Public / Private	*d* = 0.31	Small

Discussion

This paper was derived from an examination of the continuous debate over whether teacher training in technology impacts a student's learning and use of technology. While no direct causal effect can be determined from the NAEP data, it is possible to provide some insights from this analysis of the 2014 TEL dataset.

As previously identified in the literature review, the research questions of this study were determined based on current literature that reports mixed results regarding whether teacher content-specific training improves student learning of a subject. The results of this study lend support toward the argument that it may be true with regards to technology-specific professional development for teachers. The following further explains the results found.

Research Question #1

Are TEL scores of 8th-grade students higher for schools whose teachers have had technology and engineering training than of students in schools where teachers have less training in technology and engineering?

In this study, the two school-reported variables addressing teacher professional development (PD) in technology were used to address this research question. Tables 1 and 4 provided an opportunity to examine school-reported responses regarding the percentage of teachers with technology-related PD in their schools. Looking at the National Schools jurisdiction, schools that reported having any percentage of teachers being trained in technology on average had students scoring higher than students where schools reported no teachers were trained. This is consistent in studies (Harris & Sass, 2011; Henry et al., 2014) who studied teacher training and credentialing. They found that the more education the teacher had in their field, the better the student performance. This study demonstrates that students in schools where teachers have technology training, students on average are likely to score higher than students in schools where technology training for teachers has not occurred.

Research Question #2

Are TEL scores of public school students greater than those of non-public school students where schools with teachers who have had training in technology and engineering?

Addressing this question required looking deeper into the summary data to see if differences existed between jurisdictions. For this question, it was necessary to compare variable levels (Variable 1:

tables 2.1 through 2.5 and Variable 2: tables 4.1 through 4.5) to arrive at a complete analysis. At almost all variable levels, national private school students on average scored significantly higher than public school students on the TEL assessment. The results suggest that for schools who reported that they had teachers who received technology-related training within the past two years, there is a likelihood that on average students would have TEL assessments that would be higher in the private schools than in the public schools. The results here support anecdotal evidence that students in private schools perform better than students in public schools. An additional exploration into the dynamics influencing student performance is encouraged as educators may wish to discover what causes these differences.

Additional Discovery

The results in this study reflect what researchers (Boonen et al., 2014; Darling-Hammond, 2000) have found regarding mathematics content that a teacher's background has the most significant impact on student success. As identified in this study, technology may be content that also requires a level of expertise to teach effectively. A future study may explore whether technology is a content area like mathematics where teacher professional development is a benefit toward ensuring student success.

This study offers support for more empirical research into the role of teacher professional development in technology and technology integration. The results suggest that there is a possibility more information can be gleaned regarding the teaching of technology and student technological success.

Limitations of Study

Several areas limited the scope of this study. The study was only able to use summary data using the NAEP Explorer analysis tool. There was no access to the raw student or school data. Therefore, only a limited data analysis of the summary means and standard deviations were possible.

Direct teacher-reported data was not collected as part of the 2014 dataset. School-reported data was used to provide the teacher training analysis. It is hoped that future data collection will include teacher-reported responses and a further comparison can be determined. Since the responses to this study are based on is solely school-reported, it cannot be verified that a teacher who received training was, in fact, the teacher who taught any technology-related activities in the schools.

Conclusions and Future Research

The purpose of this study was to examine the connections that may exist between the 8th grade NAEP TEL score performance in the national schools and teacher experience with technology-focused professional development. Utilizing the online NAEP Data Explorer analysis tool, it was possible to examine two school-reported variables related to teacher technology-specific professional development and student TEL scores on a national level. The results presented here have provided a window into understanding more about the relevance of teacher training with regards to technology.

- Students tend to perform better with technology when more teachers have received technology-related training.
- Schools who have more technology trained teachers tend to demonstrate increased performance by students when dealing with technology.
- Private schools tend to have greater success students learning technology than students in public schools where teachers have been trained in technology.
- Private school teachers who have received technology training tend to improve student technology cognition better than teachers in public schools.

While the implications appear to be irrefutable, it is important to restate that the NAEP data cannot address causal relationships. However, it is hoped that the observations noted here will spark additional research that can empirically confirm the trends noted here.

Given the limitations expressed above and considering the results of the data presented, it is encouraged that the following be considered for possible future research:

- Empirical research on the similarities of teaching pedagogies for teaching mathematics and applying those techniques and expectations to teachers learning technology. This study has identified the possibility that methods used to teach mathematics may be useful when applied to teaching technology as similar demands on a teacher seem to exist (Boonen et al., 2014; Darling-Hammond, 2000).
- Study teachers and their level of experience with technology and how it impacts student use of technology. Limited research is only now being conducted with how technology training and support impact student use of technology (Gebre et al., 2014).
- An exploration into why private schools are doing better than public with better technology skills. Is this true at all socio-economic levels? Students in private schools consistently perform better than students in public schools where teachers have been trained in technology. Is this due to student ability, teacher education or school pedagogies.
- Would recommend that future NAEP TEL data collection includes a teacher survey that more provides explicitly questions that address teacher technology-focused credentials and professional development. This would allow for better insight into this area of study.

This study attempted to examine the influence of teacher training on student understanding of technology. There is evidence to suggest that teacher influence does exist and that it is increased when the teacher is properly trained. Educators should note the influence that teachers who are trained to use technology have the potential to have a positive effect on student technological performance.

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