2023

EXPLORING THE EFFECTS OF TECHNOLOGY PROFESSIONAL DEVELOPMENT ON THE 8TH GRADE NAEP MATHEMATICS ACHIEVEMENT

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A dissertation submitted in partial fulfillment
of the requirements for the degree of

DOCTOR OF EDUCATION

to the faculty of the

DEPARTMENT OF ADMINISTRATIVE AND INSTRUCTIONAL LEADERSHIP

of

THE SCHOOL OF EDUCATION
at
ST. JOHN'S UNIVERSITY
New York
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Submitted Date February 15, 2023 Approved Date May 19, 2023

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ABSTRACT

EXPLORING THE EFFECTS OF TECHNOLOGY PROFESSIONAL DEVELOPMENT ON THE 8TH GRADE NAEP MATHEMATICS ACHIEVEMENT

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The purpose of this study was to examine if teachers' participation in the educational technology professional development was a significant predictor in the 8th grade students' mathematics achievement on the 2013 National Assessment of Educational Progress (NAEP). This non-experimental study analyzed selected variables from the 2013 NAEP 8th grade mathematics restricted dataset. The study considered students' socio-economic status (SES), gender, race/ethnicity, teachers' educational technology professional development, tenure-certification, and professional development on mathematic peer collaboration. Factors were created in principal component analysis with promax rotation method. The researcher has also used hierarchical regression analysis to explain how much of student achievement can be predicted through the independent variables. The study was guided by the amalgamation of two theoretical framework with Bandura's self-efficacy (2013): Schulman's Pedagogical Content Knowledge (PCK) from 1987 and Mishra and Koehler's Technological Pedagogical Content Knowledge (TPACK) from 2006.

The researcher used multiple regression analysis and hierarchical regression to assess the effects of SES, gender, race/ethnicity teachers' educational technology professional development, tenure-certification, and professional development on

mathematic peer collaboration with mathematics achievement serving as the dependent variable. In the initial step of the regression analysis, SES was considered as independent variable. In the following step, the students' gender was included as an additional variable. This permitted the researcher to identify the influence of the students' gender on the amount of explained variance. In the next step, the factor of educational technology professional development along with other factors were added to the analysis. The researcher was able to isolate the effect of the factor the amount of variance explained by repeating the process and filtering it for each of the race/ethnic subgroups reported in the NAEP. All these factors were then analyzed in hierarchical regression with mathematics achievement as the dependent variable to check the level predictability by each independent variable.

Teachers should possess the necessary skills, including proficiency in technology, to develop lessons that effectively incorporate technology in instructional practices. The present study adds to the existing research that highlights the significance of technology-focused professional development for educators.

DEDICATION

To my beloved parents, Mr. Mathew and Mrs. Annakutty, who are my first teachers instilling in me a love for learning and always encouraged me to peruse my dreams. Your unwavering support and sacrifices have made me what I am today.

To all teachers worldwide whose dedication and passion keep the flame of learning alive.

ACKNOWLEDGMENTS

I thank the Almighty God for the protection and blessings He has bestowed upon me. I would like to thank The Congregation of the Mission, Eastern Province (USA) and Southern Province (India) for providing me all the necessary platform to complete my doctoral studies. I am, deeply grateful to my mentor Dr. James Campbell for his unwavering support, guidance, and encouragement throughout this dissertations journey. His vast knowledge and expertise have been invaluable, and I am truly fortunate to have had him as my mentor. I would like to thank the dissertation committee Dr. Anthony Annunziato and Dr. Richard Bernato for their insightful feedback, constructive criticism, and valuable suggestions, which have helped me to shape and refine my research. My sincere thanks also go to the staff and faculty of School of Education at St. John's University who have provided me the necessary resources and support to carry out my research. I am grateful to my loving sisters, their families, and all my confreres at Murray House who have been a constant source of love, encouragement, and support throughout this journey. Their unwavering belief in me has been a driving force behind my success, and I cannot thank them enough. To everyone who has supported and encouraged me along the way, thank you from the bottom of my heart. Your contributions have been invaluable, and I am truly grateful for all that you have done.

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CHAPTER 1 INTRODUCTION

Purpose of the Study

The purpose of the research was to analyze the restricted data of the 2013 National Assessment of Education Progress (NAEP) and determine if teachers' participation in educational technology professional development was a significant interpreter of 8^{th}-grade mathematics achievement after evaluating students' race, gender, and Socio-Economic Status (SES).

This non-experimental study used selected variables from the restricted data sets of NAEP 2013, 8^{th}-grade mathematics achievement. The analysis was conducted to create confirmatory factors of educational technology professional development, SES, parents' education, and teacher tenure-qualification. The research utilized Technological Pedagogical and Content Knowledge (TPACK), an adaption of Mishra and Kohler (2006) and the self-efficacy of Bandura (1978), as the theoretical framework for the organizational schema.

The study utilized the NAEP data set because it is the "largest nationally representative and continuing assessment of what our nation's students know and can do on various subjects (NAEP, 2019). It is "congressionally mandated and administered by the National Centre for Education Statistics (NCES) within the US Department of Education and the Institute of Education Science" (NAEP, 2019). NAEP works differently from state assessments. State assessment is conducted using different content standards, but NAEP conducts is assessment "by using a common yardstick for measurement in every state" (NAEP, 2019). Based "on the type of NAEP assessment that is administered, the data can be used to compare and understood the performance of demographic groups within … state, the nation, other states … to provide a better understanding of educational experiences and factors that may be related to students' learning, students, teachers, and principals …" (NAEP, 2019). NAEP's data collection process and techniques are well-respected and widely considered to be valid on account of the richness and verities of the data set (Harbour & Saclarides, 2020). NAEP is taken as a gold standard because it provides top technical quality and represents high-thinking assessment and content experts, state education staff, and teachers from all over the nation (NAEP, 2019). NAEP is not aiming to reform and revolutionize education. But it is serious in delivering important information in the best way possible to the different levels of decision-makers who champions the cause of managing and improving the education sector (Anrig & Lapointe, 1983). This is USA's best-known student performance measure and sheds light on how the student's achievements are changing over time (Lee, 2020).

NAEP was first conducted in 1969 and The National Centre for Education Statistics (NCES) is the authorized authority to collect students' education information under the Family Education Rights and Privacy Act. The information collected by it is solely used for the purpose of statistical analysis and no identifiers are disclosed except as required by the law and the violation of it can attract both jail and or fine (NCES, 2015). The NAEP has a complex structure of governance. By setting the general parameters of the assessment, Congress demands the NAEP to report reading and mathematics every two years and science at least once in four years. For the National assessment, NAGB formulates and instructs guidelines to conduct the assessment. National Assessment Governing Board (NAGB) is an independent congress-authorized ad entity consisting of governors, chief state school officers, educational policymakers, teachers, and members of the general public (Beaton & Zwick, 1992). The Commissioner of NCES directs the administration of NAEP (Beaton & Zwick, 1992). It prohibits under the law the comparisons of individual students' schools and districts. The assessment results of NAEP cannot be used for individual students' admission, promotion, and diagnosis of learning disabilities (Beaton & Zwick, 1992). NAEP uses a survey in order to "obtain efficient and affordable estimate of national proficiency" (Beaton & Zwick, 1992). Hence, it measures educational progress and reports the progress to educational practitioners, policymakers, and the general public to act on it (Beaton & Zwick, 1992).

The Importance of the Study

The purposefulness of this study was to determine the impact of teachers' technology use and professional development on 8^{th}-grade students' mathematical achievement. The study is aimed to have national significance by way of assisting those states and territories following a curriculum infused with technology. Further, this also provides a better understanding of educational experiences and factors that may be related to student learning, teachers TPACK self-efficacy (NAEP, 2019). Curricula across the spectrum are infused with the latest technology needs and therefore teachers must have the self-efficacy to utilize it appropriately. The results give insights into the effectiveness of teachers' use of technology and can further enhance with a plan to help teachers to improve on the best use of providing necessary technology professional development programs.

Adapting Mishra & Kohler (2006) and Bandura (1978), the Technological Content Knowledge self-efficacy will be used as the organizational framework of this study. Two centuries ago, the teaching profession was considered to be retelling the knowledge in one's content area. But in the contemporary world, it is a complicated concept requiring multiple skills simultaneously (Yigit, 2014). The contributions of Shulman (1986) helped to shape the teaching profession as a job that requires both pedagogical knowledge and content knowledge. This idea gave rise to the emergence of TPACK. Although there is no global consensus on this, a theoretical model proposed by Mishra & Kohler (2006) is widely accepted.

While technology is prevalent in American classrooms, its effective use of it is debatable. This questions the proper implementation of professional development of teachers (Muller, Wood, Willough & Ross, 2008). The focus of attention in this research are revolving around technology professional development for teachers following the adaptation of the TPACK self-efficacy theoretical framework. The study analyzed factors related to teachers' technology professional development. To understand this, variables related to the use of technology in the classroom and teachers' attendance in professional development programs (PD) in connection with 8^{th}-grade mathematics achievement are used.

Teachers' attitude toward technology and their inadequate level of TPACK affects the proper integration of educational technology (Muller et al., 2008). Based on the 2017 NAEP report recommendations, PD in educational technology should focus on the active use of technology tools by integrating them into contents and methods. (U. S. Department of Education, 2017). Although the recommendations give a general framework as guidance for the PD, they do not offer a specific framework to expand teachers' TPACK self-efficacy. Hence, professional development in educational technology is an essential program that educational technology leaders must support and implement for better learning achievement among students. It helps to groom a society well connected and productive in the globalized world of today.

Research Questions

1. Is there a significant relationship between student socioeconomic status, and 8^{th}-grade students' achievement on mathematics assessment?
2. Is there a significant relationship between student socioeconomic status, gender, and 8^{th}-grade students' achievement on mathematics assessment?
3. Is there a significant relationship between student socio-economic status, gender, teachers' educational technology professional development, parents' education, teachers' qualification, and 8^{th}-grade students' achievement on mathematics assessment for each of the NAEP-identified racial categories?

Null Hypothesis

H_o1: There is no significant relationship between SES and 8^{th}-grade students' achievement on mathematics assessments.

H_o2: There is no significant relationship between SES, gender, and 8^{th}-grade students' achievement on mathematics assessments.

H_o3: There is no significant relationship between SES, gender, teacher's educational technology professional development, parents' education, teachers' qualification, and 8^{th}-grade students' achievement on mathematics assessment.

There will be additional hypotheses based on the NAEP-recognized racial categories separately to evaluate each of the following NAEP-identified race/ethnic subgroups: White, Hispanic, Asian, and African American.

Terms and Definitions

For the purpose of this research, the following terms are defined:

Achievement Gap - It occurs when one group of students performs better than another group, and the two groups' difference is statistically significant.

Educational Technology - it is a collective term referring to all the hardware technology devices, digital technology, mass media communications programs, and software programs used for educational purposes within the classroom and outside.

Population - The total target population of all the 8th-grade students in the United States was 341,000 -both public schools and private schools (NCES, 2013).

Sample - The total student sample for the 2013 NAEP 8th grade mathematics students in the in the United States consisted of 170, 000 in 6520 schools. Fifty-four jurisdictions under the categories of private and public schools participated in the 2013 NEAP: 50 states, the District of Columbia, the Bureau of Indian Education, the Department of Defense Education Activity, and Puerto Rico (NCES, 2014).

Race/Ethnicity - Classification indicating general racial or ethnic heritage. The Office of Management and Budget (OMB) is responsible for the standards that govern the categories used to collect and present federal data on race and ethnicity. The OMB revised the guidelines on racial/ ethnic categories used by the federal government in October 1997, with a January 2003 deadline for implementation. The revised standards require a minimum of these five categories for data on race: American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, Hispanic, and White.

Socio-economic status (SES) - There are many existing definitions of Socio-Economic Status. One is the "social and economic life chances individuals experience" (Harwell & LeBeau, 2010). Drawing inspiration from different authors and definitions, a low SES means that the householder has less family income, education, and occupational status. In this quantitative study, the use of eligibility for a free lunch as a measure of a student's socioeconomic status continues to be a fixture. Researchers make this conclusion based on the National School Lunch program which certifies students as eligible for free lunch (Harwell & LeBeau, 2010). Thus, NAEP has used the National School Lunch Program as an indicator for SES since 1996 (NCES, 2015).

Organization of the Dissertation

In chapter 2, the researcher discusses a review of literature on SES, gender, race, and teachers' technology professional development including studies of TPACK self-efficacy. Chapter 3 explains the methodology of the study and Chapter 4 includes the study results analysis and discussion. Chapter 5 concludes the study by discussing the findings and limitations and making recommendations for future studies. Finally, the appendices are presented at the end with supplementary materials related to the chapters.

CHAPTER 2 REVIEW OF LITERATURE

The objective of this chapter is to review the literature to examine the relevant research in the area of SES, student gender, race, and educational technology professional development. This chapter revolves around discussing six related areas: SES, student gender, student race, classroom technology, and teacher, the development of the TPACK framework, a theoretical framework of TPACK, and TPACK self-efficacy.

Socio-economic Status

In 2015, Alordiah, Akpadaka & Oviogbodu (2015) investigated the influence of socioeconomic status (SES) on students' academic achievements. An important purpose of their study was to find out the influence SES on students' achievement in mathematics. The study specifically investigated the difference in students' academic achievement in mathematics concerning parents’ SES. The research sample consisted of 1900 students, 1008 males (53.1%), 892 females (46.9), 60.2% urban (1144), and 39.8% rural (756) in total (Alordiah et al. 2015). The stratified random sampling included senior secondary students from Delta and Edo states in Nigeria.

Using the survey method, this quantitative study used two instruments namely the mathematics objective test (MOT) and the socio-economic status questionnaire (SESQ). The former, prepared by the researchers, contained 50 items that were dichotomously scored. The latter had 20 items on a 3-point scale. The content validity for SESQ was established by making sure that the instrument contains items such as family income, parents’ educational level, parent occupation, and social status to classify people into different socio-economic status. To find out if there was a significant difference in the academic achievement of students in mathematics with respect to parents' SES, the data analysis showed a Z- value of 8.73 (*df* =1898) is significant at p=0.000. This indicates that there was significant difference in students' academic achievement with respect to their parents' SES. The findings revealed that the students from parents with high SES did better than the student from parents with lower SES. Students of parents with high SES may have done better because of the increased availability of resources, time, and money. This indicates that educators need to look into the disparity existing among students based on their socio-economics status.

Lee, Zhang, & Stankov (2019) studied SES and student achievement and tried to identify which socio-economic status variables have the predictive validity. The purpose of the study was to present relevant empirical evidence in order to discuss the predictive validity of SES in so far as academic achievement is concerned. The researchers tried to answer which SES variable/s is ideal for predictive validity while considering students' academic achievement. The study used large-scale data from the Programme for International Student Assessment (PISA). Assessment cycles 2012, 2009, 2006, and 2003 were analyzed and this 10-year period helped to examine the changes in the SES-achievement relationship. Around the world, 15-year-old students took part in the PISA program. The minimum sample size was 4,500 students in 150 schools per country. Within a school, the minimum number was limited to 20. Sixty-five countries took part in PISA 2012 (N = 485,490), 65 countries in PISA 2009 (N = 475,460), 57 countries in PISA 2006 (N = 398,750), and 41 countries in PISA 2003 (N = 276,165).

Five variables (CULTPOS, HEDRES, WEALTH, HOMEPOS, and ESCS) were measured at the scale-index level. Among them, three (cultural possessions-CULTPOS, home educational resources-HEDRES, and family wealth-WEALTH) were related to household belongings.

Albeit the reliabilities vary among countries, the median Cronbach's alpha values were: $\alpha = 0.72$ for CULTPOS; $\alpha = 0.53$ for HEDRES; and $\alpha = 0.62$ for WEALTH in the PISA 2012 data. The results showed remarkable consistency. The index of economic, social, and cultural status (ESCS) showed pan-cultural correlations with mathematics: $r = .40$ in 2012, $r = .42$ in 2009, $r = .42$ in 2006, and $r = .49$ in 2003. The ESCS's correlations with achievement in different subject areas were fairly consistent as well: $r = .40$ in mathematics, $r = .40$ in science, and $r = .38$ in reading in the PISA 2012 data. Using 10 measures, the research found that the index of economic, social, and cultural status (ESCS) and home possessions (HOMEPOS) had superior predictive power for student achievement. In calculating pan-cultural and within-country correlation, few differences were noted. Multiple regression analysis was conducted to evaluate the relative effects of predictive validities of SES measures for achievement. Home possessions, parental education, and parental occupation explained 17% of the variance in mathematics achievement. Home possession measure as a proxy for family income ($\beta = .25$, $p < .001$ for HOMEPOS) showed higher effect sizes in comparison to the parental occupation ($\beta = .17$, $p < .001$ for HISEI) and parental education ($\beta = .08$, $p < .001$ for PARED).

The study re-emphasizes the significance of SES for academic achievement with varying correlation among different variables. However, a composite measure of all the mentioned above functions as a better predictor for academic achievement compared to taking them individually. This, again, speaks to the importance of SES in the present study proposed.

Although it is a well-established fact that socio-economically disadvantaged students and schools do less well on academic achievements compared to their peers in more advantaged groups, much less is studied on how the relationship may be different if both individual and school SES are disaggregated. There are other studies (Perry & McConney, 2010) that examine the relationship between school SES and student outcome using the data from the Australia 2003 PISA and using secondary data of a sample over 321 Australian secondary schools and more than 12000 students, ranging in group sizes from 5 to 61.

Focussing both on individual and school SES backgrounds, the study computed the mean score performances of reading, mathematics, and science. The clear and consistent outcome of the analysis finds that the SES context is strongly associated with academic performance. Thus making it clear that both individual and school-level SES are substantially important enough to be considered. Irrespective of the student SES, selecting a school with higher SES benefits the students' performance. This demonstrates that students are affected by the aggregated SES of the school context. The outcome of the study is very significant as the findings suggest that the segregation of educational institutions based on SES is not a healthy method as it affects the student performance irrespective of their individual SES. Thus the study calls for an inclusive schooling system based on the SES as it affects academic performance. This validates the present study's focus on the importance of socio-economic status.

Gender Difference in Academic Achievements

The role of gender in student test scores is observed all over the world. (Falch & Naper, 2013). Research in gender-related academic achievements attracts acceptance in the United States. In a study, McGraw, Lubienski & Strutchens (2006) tried to describe the trends in gender gaps and their consistency among various student groups in mathematics achievement based on the NAEP from 1990 to 2003. The researchers were trying to answer if the gender gaps changed from 1990 to 2003 focussing, especially on the attitudes of males and females toward mathematics. The study analyzed the restricted NAEP data and revealed that the gaps are relatively small but favouring males and consistent in all reporting years. Although the average scale scores across the years continued to rise, the gap did not decrease. The researchers also found that the scale score was not evenly distributed across mathematics percentiles and content strands. More males than females were found to be scoring at the advanced and proficient levels in academic achievement across different grades. Considering the gender differences within racial groups, the study found differences favoring male students among those identified as Hispanic and Whites. But no such differences were found among Black students. The analysis of 2003 NAEP data also revealed that male students more likely reported that they were good at mathematics compared to their female peers. These results were found to be consistent with the previous studies on NAEP data. Scholars may differ in their view on these findings and might even overlook the small gender differences observed. However, it is an established fact that in understanding students' learning and mathematics achievement, the vital role of gender cannot be ignored.

Considering the gender issue, the use of Information and Computer Technology (ICT) is associated with high or low maths achievement and the association is found to be generally weaker for girls (Meggiolaro, 2018). Drawing data from the Italian sub-set of the PISA 2012, Meggiolaro (2018) studied the gender gap in mathematic achievement ICT use. The gender differences across various mathematics domains are multi-dimensional. While male students outperform female students on items based on conception understanding skills, it should be noted that girls are more effective at routine algorithmic strategies. Meggiolaro (2018) did his examination of the issues with respect to different maths domain wherein he highlighted the outcome at a complex ratio. Meggiolaro (2018) also points out that it is not computer use in and of itself that matters, rather how it is used matters as far as the differences in achievements are concerned. In general, the analysis results indicate that girls' performance is not influenced by ICT compared to boys. This is suggested that this variance may be influenced by the difference in male-female attitude towards technology and confidence in computer usage. The study does not prove any of the cause-and-effect perspective. It, however, provides insights into the gender-differentiated relationship existing in ICT usage and mathematics achievement in various domains.

A study was undertaken by Falch & Naper (2013) to investigate whether gender gaps among students are related to evaluation schemes. The study revolved around the hypothesis that institutions and teachers are baseline labels that harm girls. At the end of the compulsory study in Norway, the researchers utilized many assessments in a difference-in-differences framework. Gathering the data on students and teachers in lower secondary schools from Statistics, Norway, the researchers focused on their background with special attention on gender.

In findings, the study points out that female students are better rewarded in grading by their respective teachers in comparison to their male peers. It also showed that boys outperform girls in more competitive exams like the central exit exam compared to the tests taken throughout the school year. Accordingly, the study suggests that females are less effective in competitive exams than males. It also concludes that the grading gap can be more wider and girls perform relatively worse on the exams under free school choice. The study also examined if the gender grading gap exists due to the gender distribution of teachers, and indicates that teachers, intentionally or otherwise, tend to adjust the grades depending on the students' gender. Thus, the teacher-student integration seems to be viewed as teacher-initiated discrimination in students’ assessment, indicating due to student-teacher behavior. This suggests that the existing evaluation system hurts more boys than what the gender achievement gap suggests. Hence, the gender grading gap is suggested to be related to teachers’ characteristics. There is a clear indication from the study that features of gender discrimination exist differently at different places of learning and professions (Falch & Naper, 2013).

Drawing inspiration from the three studies mentioned above, the researcher concludes that gender differences vary based on factors and the nature of each study. Nevertheless, these studies point to the simple fact that there are gender differences existing in academic achievements. To implement changes, researchers suggest that attention should be given to gender bias aspects of the academic field of mathematics. The best remedial action is to initiate steps at the earliest levels in schools. An important way teachers can carry it out is by the adequate and appropriate infusion of technology into classroom teaching, especially in areas like mathematics.

Teachers and the use of Educational Technology

To explore the perception change of mathematic teachers, Lau & Yuen (2013) studied the effects of educational technology workshops on their pedagogical orientation, efficacy, and liking for technology integration. The study revolved around the question of teachers' perception of the integration of educational technology and the factors that influence changes in teachers' perceptions. A five-session workshop was conducted for secondary school mathematics teachers to enhance their knowledge and skills in the teaching-learning experience. Teachers were interested in attending the sessions and updating their knowledge and skills in ICT. Questions concerning the effectiveness of in-service teachers' professional development training in technology is a core issue as it relates to the integration of technology into the teaching-learning process.

In Hong Kong, 100 teachers voluntarily participated in this 15-hour professional training session. The majority of the participants were males (71.1%) with most of the teachers being under the age of 51 (91.9%) and had an average of 12 years of teaching experience in secondary schools. The data collection was undertaken through a questionnaire method on perceptions of education technology. The extracted factors like pedagogical orientation, efficacy, and liking were compared pre-and post-training. The results give significant effects of training on efficacy and pedagogical orientation (t =-3.630, $p<0.001$ and t = -2.285, $p<0.05$ respectively). This was not the same for liking, and for gender, age, experience, and class taught, a series of paired sample *t*-tests were conducted to check the effects of teachers' characteristics on teachers' perception changes. Statistically significant relationships occurred between male gender and efficacy (t =-3.189, $p < 0.01$), female gender and pedagogical orientation($t = -2.179$, $p < 0.05$), age group 21-30 and efficacy ($t = -3.071$, $p < 0.01$), age group 21-30 and pedagogical orientation($t = -3.162$, $p < 0.01$), age group 41 or above and efficacy ($t = -2.857$, $p < 0.01$), the experience of teaching not crossing 10 and efficacy ($t = -3.348$, $p < 0.01$), the experience of teaching not crossing 10 and pedagogical orientation($t = -2.735$, $p < 0.05$), junior class teachers and efficacy ($t = -3.204$, $p < 0.01$), junior class teachers and pedagogical orientation ($t = -2.185$, $p < 0.05$), and teachers with no ICT in mathematics training and efficacy ($t = -3.697$, $p < 0.01$).

Teachers who occasionally used ICT-based teaching measures exhibited an increase in their perceived efficacy. In comparison with the younger teachers, senior ones improved their perceived self-efficacy but data shows they didn't believe in the benefits of ICT technology in classroom education. From the structure of the workshop, Lau et al. (2013) pointed out the emphasis on pedagogical knowledge (PK), technological knowledge (TK), and pedagogical content knowledge (PCK). However, little or no attention was paid to how to integrate technology into teaching practices. This throws light into the fact that the existing PDs do not seem to be interesting to teachers and attention is needed to rework the sessions, exposing the misalignment between practice and research in the education sector. This gives the insight that PD in technology is a crucial component to bring in effectiveness and change among teachers. And points out the existing gap between senior teachers' perceived efficacy and faith in the educational results of technology usage.

In order to identify the relationship between teachers' attitudes toward technology and their ICT engagement with it, Varol (2013) conducted a study among 100 elementary school teachers in Turkey. Teachers' role is crucial in the process of technology integration in education. In order to implement that, it is important to understand teachers' attitude and their willingness to use ICT. Of the total sample, 45% were females and 55% were males with 59% of the teachers experience 11 years and above. The data collection was conducted through questionnaires to identify if teachers' technology engagement predicts their ICT attitude and self-confidence level. The study found that teachers had low level of ICT usage in classrooms and insufficient knowledge of ICTs. The result goes in line with previous researches that studied teachers' technology usage and knowledge. The study also reveals that there is no guarantee that if teachers' usage of ICT is supporting student-centred learning. If teachers are provided with better opportunities to engage with computers and have more knowledge of ICT, they will have more a positive attitude toward it. As far as the sample is concerned in the study, it is smaller and suggests the need to look at a larger sample.

Observing that the use of ICT integration provides new challenges for teachers in their instructional process, Umar & Hassan (2015), conducted a study to assess the level of integration and its effects on the teaching-learning process. Out of 7320 randomly sampled Malaysian teachers for the study, only 2661 responded to the questionnaire. The sample consisted of 25.3% (672) males and 74.7% (1989) female participants. Using a two-dimensional model of theoretical framework, the study focused on teachers' level of ICT integration, the effects of ICT on teaching, and the effects of ICT on students 'learning. In terms of the level of integration demonstrations, the use of ICT and teaching computer skills showed a very low level (M= 2.01). Although the majority of teachers agree that using ICT had effects on their teachings, they were confronted with the issue of lack of time. This affects the completion of syllabus. Teachers agree that house training is important for their professional and career development; however, they are of the opinion that the existing ones need to be revised as they do not meet the expectations of teachers. While assessing the effects on students' actual learning, the majority of the teachers believe that ICT integration had a positive impact on students' independence and learning. In general, the result indicated that teachers' ICT integration is still at a lower level despite it positively affecting both teaching practice and students' learning. This stresses the importance of further training in professional development for teachers.

In order to understand the quality of teachers' work, the study undertaken by Maksimovic & Dimic (2016) suggests that competence, development, and strengthening are important. In order to arrive at the conclusion of the study, the researchers questioned the teachers' attitudes regarding the use of ICT in the classroom. The objective of the study was to question the attitude of teachers with regard to their competencies in using ICT in classroom. This is carried out taking into consideration gender, experience, and education qualification.

The study consisted of 100 primary school teachers as sample respondents. A total of 38 males (38%) and 62 females (62%) took part in the city of Nis in the years 2015. A Likert scale consisting of 31 items was developed only for the purpose of this study. The scale focused on teachers' attitudes, teachers' self-development, competencies in using modern-day ICT, and teaching practice research. In the factor analysis, components like ICT seminars, lack of competence, ICT in teaching, skills, competencies, mastering, application, interests, and linguistic competence were extracted. Teachers understand the importance of ICT competencies. The results showed that there is no significant difference with regard to gender, experience, and qualification. Teachers value ICT competencies very highly, but lack of proficiencies and competency realization are matters of great concern. Thus, in this study, Maksimovic & Dimic (2016) indicate the importance and need for teachers' professional development with focus on information competencies development and its application for the best realizations of teaching-learning experiences.

To examine teachers' views and usage of technological tools in science classrooms, Beşoluk, Kurbanoğlu, & Önder (2010) carried out a study among pre-service and in-service teachers in Turkey, using a technology questionnaire to collect data, a sample of 33 in-service and 76 pre-service (4th graders) science and technology teachers. Of the sample, 58.7% were females and 41.3% were males. The research indicated the statistical difference between in-service and pre-service teachers in terms of the latest computers.

In the analysis of the gathered data, statistically, significant differences were observed between teachers and pre-service teachers in their current knowledge of computer usage (t (107) = 2.811, p=.006); difference among groups of teachers that differs in experience in terms of how computers can be used (F (3,32) = 6.55, p=0.02); and teachers define the frequency of using technological tools by students while preparing homework as medium (X=3.04). The study shows that teachers in general have the awareness of the importance of technology and its usefulness in teaching. There is also a need to continuously update technology knowledge as it develops fast. In the light of what is stated above, the study also recognizes the importance of participation in professional development programs, which are confronted with difficulties such as economic support, lack of material references, and latest resources. All data indicated above clearly points out the importance and relationship existing between educational technology and teachers' professional development.

From PCK to TPACK: Development and Growth

In order to achieve the objectives designed in the curriculum, we need to start with technological pedagogical and measuring. In communicating knowledge to the students, the greatest difficulty has always been the task of measuring teachers' ability to translate knowledge to their students. Here comes the idea to quantifying teachers' performances in order to evaluate the teaching-learning process.

Pedagogical Content Knowledge (PCK) was a concept first introduced by Shulman (1986) in the '80s. In Shulman's opinion, PCK was not anything new to the system of education because, from the writing of the 1950s, early universities considered both content and pedagogy as an indistinguishable body of knowledge whereby pedagogy was about how to teach and content was about what is known (Shulman, 1986). This refers to the understanding teachers have on how to use and translate their knowledge in a particular subject matter to students. Shulman (1986) illustrates this through his detailed narrations on the medieval university style of graduating and becoming a doctor of philosophy (Shulman, 1986). Thus, he points out the claims that the sharp distinction between content and pedagogy was comparatively of recent origin and not found in the medieval university system. The reason for him to propose the idea of PCK was regarding the perception of teaching. It was often considered a non-professional career compared to other careers like doctors and lawyers. He speaks about PCK as the integration or amalgamation of content and pedagogy that primarily deals with the *how* and *what* of teaching. In his proposition of the “missing paradigm” (Weston & Henderson, 2015; Shulman, 1986), he points out the blind spot existing in teaching. Accordingly, “what we miss are questions about the content of the lessons taught” (Shulman, 1986). Integration of pedagogy and content has long been searched by scholars all over in order to give recognition to the job of a teacher as a profession in its normally understood term.

This new understanding of teaching and its complexities necessitated the advent of a new theoretical framework which Shulman proposed through his perspective on teacher education. He proposed three categories of content knowledge: pedagogical content knowledge, subject matter content knowledge, and curricular knowledge (Shulman, 1986).

Content Knowledge

For Shulman, Content Knowledge (CK) is referred to as "the amount and organization of knowledge per se in the mind of the teacher" (Shulman, 1986). He mentions several existing ways of how CK can be presented, taking inspiration from ancient university systems, he says that knowledge is considered to be something beyond the conceptual domain. In theory and practice, teachers must be in a position to explain why a proposition is considered right and acceptable. Accordingly, the teacher needs to have a comprehension of that subject matter along with an understanding of “why this is so” (Shulman, 1986).

Pedagogical Knowledge

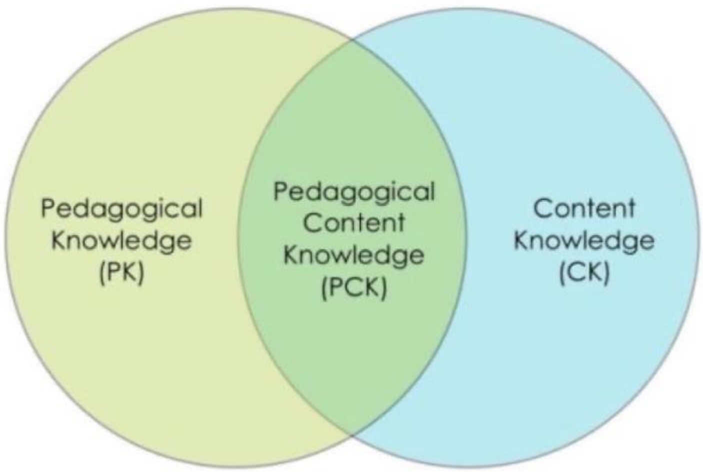
This is the second kind of content knowledge Shulman (1986) proposed. For him, this is beyond the knowledge of the subject matter and deals with the dimensions of teaching a subject matter. Accordingly, this is also a type of content knowledge that represents the ways and formulations in which the subject matter is made comprehensible to its audience. There is no single way to represent the subject matter. Teachers must have alternate ways and means derived from research and practical wisdom. They also need to have the knowledge of how understanding a concept can be easy or difficult for learners.

Curricular Knowledge

This knowledge involves a whole range of programs in order to teach a particular subject matter at a specific level. Here, the teacher must understand everything about teaching the concept; which tools to be used, what are the alternate texts, the visual materials needed, software programs, etc. Here, individual students' needs are to be kept in mind. And on the forms of teachers' knowledge, Shulman (1986) proposed propositional, case, and strategic knowledge. Under these forms, the particular categories of knowledge are organized. Shulman's PCK theoretical framework gained significant popularity in the academic research area and after about four decades since its introduction, PCK remains useful and very influential on teacher education and/or teaching. It is a useful idea because it helps teachers to understand the teaching process and create workable instructional tactics in course methods Abell (2008). In the contemporary world, it is an undeniable fact that every subject matter is permeated with fast-developing technology and technological devices. In such a situation, researchers propose an amalgamated theoretical framework of technology with PCK. The main proponents of this inspired use of technology are Mishra & Koehler (2006). The factorial structure is diagrammatically represented by two circles in figure 1.

Figure 1

Pedagogical Content Knowledge Framework



Pedagogical content knowledge framework from "Factors Influencing the Technological Pedagogical Content Knowledge (TPACK) of English Teachers in Primary Schools, Chiang Mai Primary Educational Service Area 1" p. 2983 by W. Boonsue, 2021, *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(8).

TPACK: A Framework for Teacher Knowledge for Technology Integration and its Factorial Structure

The use of educational technology has the burden of being attacked for lacking a theoretical framework. Basing themselves on Shulman's PCK, Mishra & Koehler (2006) proposed a new conceptual framework for educational technology after having conducted extensive research for five years. Although there was no discussion of technology in relation, content and pedagogy in Shulman's research, these issues are significantly important matters to be considered with regard to the surrounding technologies in a traditional classroom. The noticeable difference is the changed nature of classrooms with new technologies in them. Technology is going to stay there even if all teachers are not embracing it in their teaching activities. In the current situation of technology, it shares similar problems Shulman discussed in the early 1980s. According to Mishra & Koehler (2006), the relationship between pedagogy, content, and technology are complex. Mishra & Koehler (2006) discuss that these three not in isolation as many of their contemporaries did, rather they specify the relationships existing between them in pairs: Pedagogical Content Knowledge PCK, technological content knowledge TCK, technological pedagogical knowledge TPK, and technological pedagogical content knowledge TPCK. Mishra & Koehler (2006) attempted to highlight the essential knowledge teachers need for integrating technology. The researchers addressed the multifaceted and complex nature of this type of knowledge. For them, the use of technology in pedagogy needs to develop a complex and situated form of understanding named as Technological Pedagogical Content Knowledge (TPCK). This is found to be similar to what Shulman proposed, the relationship between content and pedagogy named Pedagogical Knowledge Content.

Technology Knowledge (TK)

This is the knowledge about the use of standard technologies, both conventional and contemporary. As technology is one progresses, TK remains in a state of flux on account of the fast characteristics of change of technology and due to the changeable nature of technology. Standard technology workshops will be focussed on the acquisition of operating skills. But technology is in constant change; TK needs to be considered along with the signs of change.

Technological Content Knowledge (TCK)

This can be described as the knowledge that results from the reciprocal relationship between technology and content. Technology has impacted and introduced new affordances on how teachers can represent content that was formerly not possible. It is not only enough for teachers to know just the subject matter but also the way in which subject matter can be altered through the implementation of technology. It also enables discovery of new content and how differently it can be represented.

Technological Pedagogical Knowledge (TPK)

This is the mutual relationship between technology and pedagogy. It is also about understanding, and possibilities of change in teaching, using a particular technology tool in a specific pedagogical approach. Making the way for how certain activities in the classroom are implemented, technology has the affordability of new methods and locations of teaching. Thus, there is a large variety of technological tools available for teachers for their pedagogical assistance. This is most visible in the recent applications of online teaching.

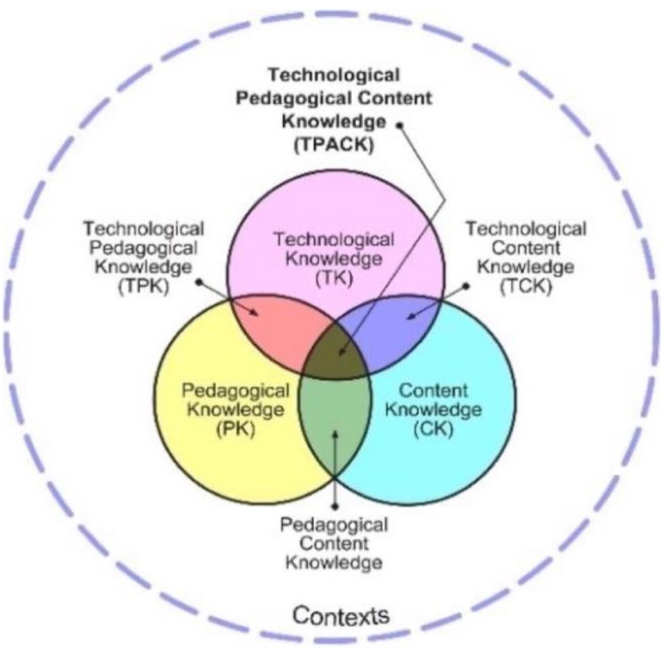
Technological Pedagogical Content Knowledge (TPACK)

This is the synthesis of the above-mentioned bodies of knowledge, with a special focus of attention on "how technology can be uniquely crafted to meet pedagogical needs to teach certain content in specific contexts" (Koehler, Mishra, Akcaoglu & Rosenberg, 2013). Each of the constituents in the TPACK is a significant and necessary aspect of teaching. Effective teaching is beyond considering them as independent pieces, rather a synthesized use of the knowledge of technology, content, and pedagogy designed for a better student-learning experience. It is about effective teaching with technology and

"TPACK framework is a testament to the complexity of teaching … (and) also functions as a theoretical and a conceptual lens for researchers and educators" (Koehler et al. 2013) in order to evaluate their teaching ability and measure their preparedness to teach effectively using technology along with all other above-mentioned contents. The intertwined nature provides educators with a plethora of tools to deal with teaching effectively ruling out one size fits for all conventional approach. This highlights the importance and needs for technological professional development in teaching. The interactions of each component and factorial structure in TPACK are diagrammatically represented by three circles in Figure 2.

Figure 2

Interactions in TPACK



Pedagogical content knowledge framework from "Factors Influencing the Technological Pedagogical Content Knowledge (TPACK) of English Teachers in Primary Schools, Chiang Mai Primary Educational Service Area 1" p. 2983 by W. Boonsue, 2021, *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(8).

TPACK Self-Efficacy

From a general perspective, self-efficacy (SE) is considered to be one’s skills in a given field (Abbitt, 2011). Bandura (1986) describes self-efficacy as one's own judgment on one's "capabilities to organize and execute courses of action required to attain designated types of performances" which has very important implications for their choice and behavior. Teachers who have higher degrees of self-efficacy are willing to experiment with more teaching methods investing more effort with lots of enthusiasm. Schunk, Hanson, & Cox (1987) are of the opinion that teachers with low self-efficacy appear to be more anxious about teaching and invest lesser effort compared to teachers with higher self-efficacy. When faced with obstacles, they easily give up.

The application of self-efficacy in teachers’ level of technology integration and their confidence in the use of TPACK-related components can be referred to as their self-efficacy in TPACK (Saudelli & Ciampa 2016). Their self-efficacy in technology will have an impact on their way of integrating it into their teaching activities. According to Compeau & Higgins (1995), teachers with higher self-efficacy beliefs in technology will integrate technology into their teaching and will do it more effectively in their activities. Hence, it is very important to study the self-efficacy beliefs of teachers in relation to TPACK. Although TPACK self-efficacy is developed in a study by Bilici, Yamak, Kavak, & Guzey (2013) to be comparatively new, it bases itself on the TPACK framework. In a study undertaken by Rohaan, Taconis, & Jochems (2012), it is found that teachers’ self-efficacy in relation to their ability to handle technology tools has a significant influence on their attitude towards technology incorporation in classroom teaching. The researchers also observed that teachers' improved TPACK knowledge influences their self-efficacy belief, eventually resulting in increased technology use in their classrooms.

In short, the theoretical understanding of the TPACK conceptual framework with self-efficacy belief consistently and progressively affect teachers' classroom practices; the implementation of which will result in higher student achievement. In the next chapter, the researcher discusses the methodology followed.

CHAPTER 3 METHODOLOGY

Purpose of the Study

The purpose of the research was to analyze the restricted data from the 2013 National Assessment of Educational Progress (NAEP) and determine if teachers' participation in educational technology professional development was a significant interpreter of 8^{th}-grade mathematics achievement after evaluating students' race, gender, and Socio-Economic Status (SES). Independent variables were identified from students' and teachers' background questionnaires. Mathematics achievement of 8^{th}-grade students was the dependent variable. In this chapter the researcher explains the following topics: (a) research design (b) an overview background of NAEP, (c) sample and population, (d) the NAEP database, (e) variables, (f) instruments, (g) reliability and validity, (h), NAEP procedures of data collection (i) data analysis, and (j) protection of human subjects.

Research Design

In this non-experimental study, the researcher used selected variables from 2013, 8^{th}-grade mathematics National Assessment of Educational Progress (NAEP) restricted dataset. The research outcome will support educators and policymakers on the need for advanced and informed decisions for teachers' technology professional development. Through principal compound factor analysis, factors were created for Socio-economic Status (SES) parents' education, teacher qualification, and educational technology professional development. This was further utilized for a multiple hierarchical regression analysis to explain how much student mathematics achievement can be explained with each factor as an independent variable. The researcher used Shulman's (1986) Pedagogical Content Knowledge (PCK) framework and Mishra and Koehler's (2006) adaption of the Technological Pedagogical Content Knowledge (TPACK) framework along with Bandura's (1986) theory of self-efficacy as the organizational structure. The study relied on the purposefully selected NAEP-restricted data set for the analysis.

NAEP: A Short Background

The National Assessment of Educational Progress (NAEP) assessments began in 1969; authorized and funded by the federal Elementary and Secondary Education Act (ESEA). It is a congressionally mandated program administered by the National Center for Education Statistics (NCES), within the U.S. Department of Education and the Institute of Education Sciences (NAEP., 2021). The NAEP provides policymakers and leaders at the federal and state level a measure to guide important decisions on educational resources and funding (KANSAS Department of Education). It is also called the Nation's Report Card and is considered the gold standard for large-scale assessment. It is the "largest nationally representative and continuing assessment of what our nation's students know and can do in various subjects such as mathematics, reading, science, and civics" (Illinois State Board of Education NAEP). It gives precious insights into students' educational experiences and opportunities to learn in and outside of the classroom. These assessments follow the frameworks developed by the National Assessment Governing Board (NAGB) and use the latest advances in assessment methodology (Illinois State Board of Education NAEP). Results are made available for distinctive student groups, based on factors such as race/ethnicity, gender, school location, and more. NAEP is not devised to gather or account for results for students, classrooms, or schools (NAEP, 2021). It gives us a good sense of the direction the nation is moving and provides valuable data with long-term trends (TN Department of Education).

Research Sample and Population

In 2013, NAEP assessed 341,000 eight grade students in mathematics. National participation, including the District of Columbia, and the Department of Defense, comprised of 170,000 students, and 6520 schools, both private and public. In 2013, weighted national participation, before unwilling schools were replaced for the mathematics assessment, was 97 % for 8 graders, 99 %, and 70% for public and private schools respectively. Grade 8 had a 93% weighted participation rate (NCES, 2013).

Most of those who participated in the 2013 NAEP evaluations of mathematics, achieved or surpassed the 95% inclusion goal. Even though the target sample for twelfth grade was 60 students, schools with 66 or more students were all studied. The entire procedure, such as the process of submitting the list, students sampling from year-round schools, new enrollees sampling, and defining student suitability, and rejection status was the same as the process used for the NAEP state sample. The outcome and analysis of the study take into consideration some of the limitations of the study, including over-testing certain racial/ethnic students while under-studying students in small schools. Things like the process of submitting a list, students sampling from year-round schools, new enrollees sampling, and defining student suitability and rejection status were just the same as the process used for the NAEP state sample. This is just because every individual school participated in the assessment, and individual students assessed, represent only a part of the bigger population of attention. The assessment results are weighted to account for the unequal depiction of certain groups in the sample (NCES, 2013).

The NAEP Database

On account of the special feature of measuring the achievement of 8^{th}-grade mathematics students, the stratified random sampling technique, the researcher ascertained that it is the most appropriate data set for this study. This is one of the richest data sets available and almost all complications are addressed with several techniques of experts (McGraw, Lubienski & Strutchens, 2006). NAEP survey questionnaires are designed and developed by experts in the field, like education researchers, statisticians, and teachers. This is carried out to make sure the collected information becomes most valuable for policymakers and educators (Havard, Nguyen, & Otto, 2018). It represents all types of races, schools, SES, states, ethnicities, locations, etc.

Variables

For this non-experimental quantitative study, the researcher finalized on independent variables such as students' SES, parents' education, teachers' education qualification, gender, race/ethnicity, teachers' educational technology professional development, teachers' tenure certification, and professional development on mathematic peer collaboration. They were extracted from the NAEP-2013 questionnaire items answered by both students and teachers. These were achieved after a process of component reduction analysis. The list of these independent variables with item codes given in the database are listed.

Instruments

NAEP framework decides what skills and knowledge are to be assessed in mathematics and the framework was developed by NAGB. In order to measure each student, individual assessment questions were developed, reviewed, and refined by

NCES. The Governing Board and a committee that consists of subject matter experts, practitioners, researchers, educators, business leaders, and policymakers work together. This resulted in the development of a quality set of curricula standards that defined what students should be able to *do* and *know* in a specified subject. In order to check the trends in student performance, the frameworks were devised to remain unchanging for the maximum duration of time (NCES, 2013).

Questionnaires were also designed to capture students' educational experiences as part of NAEP to contextualize the assessment results. Nevertheless, it maintained that all frameworks were responsive to an equal level of international and national standards. This gives a platform, without advocating any specific type of approach to instruction, for conversations on quality educational standards and assessments (NCES, 2013).

The framework is comprised of both cognitive and contextual items. The cognitive items consisted of scenario-based tasks, hands-on tasks, selected response, multiple choice -including multiple-select, drag and drop, zone, drop down, constructed response, short constructed response, and extended constructed response. And the contextual questionnaires consisted of “students (demographic characteristics, opportunities to learn in and outside of the classroom, educational experiences), teachers (training, instructional practices), schools (policies, characteristics)” (NCES, 2013). The created questionnaires were reviewed by content experts and teachers for political sensitivity and bias. They were also reviewed by standing committees that assess the appropriateness, representativeness, and quality of items.

For contextual questionnaires, NCES gets the Office of Management and Budget (OMB) involved, to check and to make sure that the government policies are followed.

Efforts were taken while developing questions that are grounded in educational research and the relevant answers were provided to the subject being assessed. While keeping the requirements met, questionnaires were designed to minimize the burden on participants.

In the assessment design, the cognitive items are located in blocks. These are placed in a booklet, along with one block of a student survey questionnaire. Booklets were loaded to tablets following a process. In short, students who are sampled to answer two 30-minute cognitive blocks will also receive 15 minutes of survey questions. This is pilot tested at national level for clarity, difficulty, timing, feasibility, and for other administrative logical considerations. Based on the pilot test, the items are revised and reviewed following the same procedure mentioned above. After the final approval, the assessment was deemed operational.

Reliability and Validity

NCES follows the strict NAEP scoring process that implements validity checks and quality control at every stage of a five-stage procedure that includes rubrics development, training materials development, pilot scoring, operational scoring, and trend scoring/monitoring. As far as the NAEP mathematics assessment is concerned, the conclusions drawn on the progress in mathematics are sufficiently robust and therefore support the validity of the findings. Although there exists gap among subgroups, the NAEP assessment indicates a consistent rise in achievement for all the subgroups. (Daro, Stancavage, Ortega, DeStefano & Linn, 2007).

Daro, Stancavage, Ortega, DeStefano, & Linn, (2007) note that there is no evidence to show that NAEP underestimates or overestimates the overall results. The test administrators of the NAEP survey make sure that the assessment is carried out in a uniform fashion with same sets of questionnaires in all 50 states and four other jurisdictions. "The National Assessment Governing Board oversees the development of NAEP frameworks that describes the specific knowledge and skills to be assessed in each subject" (NAEP, 2013). The assessment framework is designed by qualified experts and very few changes are made every year to the questions. This makes it unique and provides a clear depiction of academic progress over the period of many years. NAEP assessments of eighth-grade mathematic students are based on nationally represented samples. The mathematics assessment measures students' skills and knowledge in mathematics (NAEP, 2013). It also assesses the ability of students to apply their knowledge in problem-solving situations. Students are asked to respond to multiple-choice questions designed to measure what they can do and know across the areas like algebra with a framework typical for pre-algebra. This is broader in specifying functions, data analysis, and probability with more sampling and experiments, geometry with more content, measurement with more below-grade-level content, and a number of operations with a typical emphasis on decimals and fractions. On a scale of 0-500, the performance of students is reported as average scores. NAEP scales and achievement levels are developed independently of each subject and therefore cannot be compared across subjects (NAEP, 2013).

Expert reviewers ascertained that the NAEP item pool is broadly associated with the framework. If one judges it against those of the states and nations chosen for comparison, the adoptions done by the NAEP framework appear realistic. Algebra is the most heavily weighted content area in the NAEP framework in eighth grade, with 30 percent of items (Daro, Stancavage, Ortega, DeStefano, & Linn, 2007). In the present study, the researcher conducted additional checks on the reliability and validity of the variables selected. In SPSS, factor analysis were conducted to check validity through Principal Component Analyses (PCA) which is “the basis for multivariate data analysis” (Wold, Esbensen & Geladi, 1987). After factor loading for each factor, the reliability check were carried out by an online Composite Reliability Calculator (Colwell, 2016) for each independent variable separately. The NAEP framework has the following five items for Grade 8 (NAEP, 2013):

Number of Properties and Operations: The typical emphasis is less squares, and square roots, more decimals, and fractions.

Measurement: More below-grade-level content, less connections to other content areas.

Geometry: More content.

Data Analysis and Probability: More sampling and experiments.

Algebra: Typical for pre-algebra, (does not cover algebra I), more broad in specifying functions.

Data Collection Process

NAEP is administered to students across the entire nation by trained representatives. They are supported with the help of school coordinators as well. The approximate time duration of the test completion is 120 minutes for students. A team of three to four NAEP representatives has the responsibility to set up and administer the assessment. It is the responsibility of NCES to provide all the necessary test-taking technological equipment for the smooth conducting of the tests (NAEP, 2013). It is the duty of the school to provide space, furniture, and electrical outlets. The sampled school will have two sequential sessions conducted with an average of 25 students in each session. Students receive the necessary tutorial on how to take the test prior to the actual assessment; this includes a number of previously released questions. Questionnaires are administered in tablets to students that keep a record of information on their learning experiences (NCES, 2013).

Having signed the NAEP code of ethics, the representatives received extensive training to collect and safeguarded the assessment data, who guaranteed the integrity and accuracy of the data. The schools designated necessary coordinators to assist the NAEP representatives to carry out the assessment (NCES, 2013). After having loaded the tablets with the final and approved assessment, the National Center for Education Statistics (NCES) carried out and coordinated the logistics to reach the Nation's Report Card, supporting materials, and other assessment equipment to all administrators. In order to execute this activity, it used the materials distribution system software which has the modules like information containing shipping addresses, scheduled assessment dates, student names, student demographic information, and a listing of all materials available for the use by a participant in a particular subject. To ensure the quality of the whole process, it imaged the tablets and ensured all assessment supplies were packed in safeguarded distribution boxes for every classroom setting. After having scanned into an inventory control system via bar code and unique number, they were sent to all the assessment coordinators all over the country. The design of the process made sure that all participating students received “predetermined proportions of different types of items on the tablets—is done according to the pattern specified by NAEP test developers” (NCES, 2013). This guaranteed that the sample size requirement for each subject for every grade is well captured.

Once students have completed giving responses to the questions on their digital assessment tablets, the NAEP representatives submitted the response data from the administrator's tablet to a central server so that the responses can be exported for scoring. The NCES oversaw the scoring process electronically and employed human scorers for other short or extended constructed-response items (NCES, 2013).

Data Analysis

In order to determine the extent to which the students' Socio-economic Status (SES), teachers' educational technology professional development, parents' education, gender, race, and teacher qualification could predict 8^{th}-grade NAEP mathematics achievement, all variables were extracted from the NAEP 2013-restricted data sets files. This was carried out using the NAEPEX software that was provided as part of the NAEP data toolkit (NAEPEX, 1999). Then, the data were imported to conduct the statistical analysis such as descriptive statistics and factor analysis. After the required re-coding, principle component factor analysis was conducted to reduce the number of components. For the factor loading, each item should be at least .30. Using Kaiser Guttman retention criteria of eigenvalues greater than 1.0 was used to determine if the factor can be acceptable. In addition, Cronbach alpha-the reliability measure was calculated using the online compound reliability calculator. By means of AM software-the statistical software designed for the NAEP data set- the select data were imported and conducted the principle component plausible values regression analysis. A combination of 20 variables for mathematics achievement was used as the dependent variable for all independent variables in the regression analysis.

Protection of Human Subjects

First of all, the researcher completed all the Institutional Review Board (IRB) processes as it is mandated by St. John's University for all those who conduct any research works. To protect the human subject, the researcher undertook a federally regulated course with test questions and obtain a pass certification. The researcher has completed it and the certificate was sent to the IRB of St. John's University with an application for the proposal approval. No human subject were harmed and the study is dealing with only the secondary source of data published in 2013. No personal details other than gender, race, and qualifications were accessed. Anonymity regarding respondents were maintained as required by the protocol. This ensured the confidentiality of the participants.

CHAPTER 4 RESULTS

Introduction

This chapter presents the findings from data analysis conducted to determine if the identified variables and factors were significant predictors of the 2013 NAEP 8th grade mathematics results. The results of the data analysis are discussed in this chapter. It includes the results of descriptive statistics, factor analysis, plausible value regressions, t-tests, and hierarchical multiple regression. In addition, the researcher ran a separate analysis for each of the major four NAEP-identified subgroups of race/ethnicity-White, Black, Hispanic, Asian-to assess if this regression analysis was significant for each identified independent variable.

Socio-Economic Status (SES) Variables

The questions related to National Lunch program eligibility, access to the internet, clothes dryer just for the family, dishwasher, more than one bathroom, and your own personal bedroom are included in factor analysis for the purpose of SES. The NAEP started collecting data on NSLP in 1996 as an indicator of poverty. Based on the available school records, either currently not eligible for the free or reduced-price school meal or eligible. For students' family income, the eligibility criteria for free/reduced-priced lunch was determined according to the existing federally established poverty level. Students who hail from families with an annual income of less than 130 percent of the poverty level were classified as eligible for free lunch. Those students who come from families that fall between 130 percent and 185 percent of the poverty level were classified to receive reduced price lunch (Beaton et al., 2011).

To conduct this study, the researcher selected National Lunch program eligibility SLUNCH, access to internet B0267A1, clothes dryer just for the family B0267B1, dishwasher B0267C1, more than one-bathroom B0267D1, and your personal bedroom B0267E1. For the purpose of this study, the researcher chose the above-mentioned variables because they provided the most detailed responses of students’ or school that participated. The SLUNCH variable reports: not eligible, reduced-price lunch, free lunch, information not available, the school refused information, and those not participating. All other variables (B0267A1, B0267B1, B0267C1, B0267D1, and B0267E1) report: multiple, yes, no, I don’t know, omitted, and not reached. The researcher, for the purpose of this study, recoded the values of information that are not available, school refused, omitted, I don't know, and not reached as missing values. This helped the researcher to arrive at a more accurate measure of non-participation for use in the plausible regression. In this study, the researcher used the first three responses as codes 1, 2, and 3 while all other codes were valued as missing. Although it might affect in the reduction of sample size, it provided a more accurate representation of students' SES variables chosen among the sample. Lower students' SES represents a higher score on the variable SES.

Student Gender Variable

For the purpose of this study, the researcher used the derived variable named DSEX for the second step of the regression analysis of the research question. The researcher used student gender to account for any variance in the dependent variable in the regression analysis step. The gender variable contained coded 1 for males and 2 for females, thus implying a positive score on the DSEX variable represents female students the negative represents male students.

Student Race/Ethnicity Variable

For the purpose of this study, the researcher used the derived student race variable named SRACE10 to account for any variance in the dependent variable prior to the final plausible regression step of teacher technology development. The race/ethnic variable contained coded 1 for White, 2 for African American, 3 for Hispanic, 4 for Asian, 5 for American Indian or Alaskan Natives, 6 for Native American /Pacific Islander, and 7 for non-Hispanic.

Professional Development of Computers Variable

In the present study, the selection of the variable professional development of computers and other technology T087708 was deliberate as the researcher followed the TPACK theoretical framework in it. Therefore, the primary and most important component is the use of technology in professional development. Thus, the core is of researcher's interest, in this study, is teachers' access to technology professional development for effective use in the classroom. The variable was coded; 0 for multiple, 1 for not at all, 2 for small extent, 3 for moderate extent, 4 for a large extent, and 8 omitted. This variable was directly used without altering or recoding as this is the major component of the study framework.

Other Variables

In this study the researcher also used other variables like students' parents' education, students' use of computers and internet for math study, students' use of calculator for math learning, teacher qualification graduate, teacher qualification undergraduate, teachers' tenure and certification, professional development on math peer collaboration, professional development on math instruction, and students use of computer in math class. The purpose of using these variables was to do a multiple hierarchical regression to determine to what extent teachers' professional development on computer use and technology can predict students' math achievement. This highlights again the importance of technology training for teachers even in a combination of analysis with other combination variables mentioned above.

Factor Analysis

A factor analysis using the principal component extraction method and a promax rotation was conducted on the select variables of NAEP sample of eight grade math achievement score. The researcher used the Kaiser-Guttman retention criteria of eigenvalues greater than 1.0 in order to verify if the factor was accepted in a standard way (Meyers et al., 2005). In addition, the researcher included items that had a component weighting of at least .30 in a factor. Finally, for each of the factors, an estimation of composite reliability for congeneric measures was calculated using the online composite reliability calculator (Colwell, Scott R. (2016).

Factor: Socio-Economic Status

To create a robust SES factor, the researcher added five more variables to National School Lunch Program Eligibility: access to internet, cloth dryer just for the family, dishwasher, more than one bathroom, and your own bedroom. A child’s home artifacts can be used as a proxy for SES. For socio economic status factor descriptive statistics, including frequency tables and bar graphs were produced using SPSS. The new factor was named STU_SES. The researcher also estimated the composite reliability based on standardized factor loading and error variances CR .788. The researcher also checked the Kaiser-Guttman retention criteria of eigenvalues greater than 1.0 to recognize if the factor was acceptable (Meyers, L. S., Gamst, G., & Guarino, A. J. 2016). The SES factor met the retention criteria (eigenvalue=2.140) and accounted for 21.40% of the common variance (Table 1)

Table 1

Factor Analysis / Principal Component Analysis SES

	Component		
	1	2	3
Natl School Lunch Prog eligibility (6 categories)		.509	
Parental education level (from 2 questions)			.936
Books in home	.511		
Access to the Internet		.475	
Clothes dryer just for your family		.668	
Dishwasher		.754	
More than one bathroom		.746	
Your own bedroom		.533	
Mother's education level			.890
Father's education level			.764
Clearly understand what teacher asks	.825		
Math work is too easy	.730		
Math work is engaging and interesting	.776		
I am learning	.756		
Math is fun	.855		
Like math	.871		
Math is a favorite subject	.850		

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.
a. Rotation converged in 5 iterations.

Factor: Students' Parents 'Education

To create students' parents' education factor, the researcher included three variables: mother's education level, father's education level, and parental education level. For students' parents' education factor descriptive statistics, including frequency tables and bar graphs, were produced using SPSS. The new factor was named STU_PARNT_EDU. The researcher estimated the composite reliability based on standardized factor loading and error variances CR .90. The researcher also checked the Kaiser-Guttman retention criteria of eigenvalues greater than 1.0 to recognize if the factor was acceptable (Mayers et al., 2016). The students' parents' education factor met the retention criteria (eigenvalue=2.007) and accounted for 20.07% of the common variance (Table 1).

Factor: Students Use Computer and Internet for Math Study

To create students use computer and internet for math study factor, the researcher included nine variables: use computer at school for math, use spreadsheet for math assignments, use program to drill on math facts, use program for new lessons in problem-solving, use internet to learn things for math class, use calculator program for math class, use graphing program for charts for math class, use e-mail/message/blog-talk w/friends about math, and use e-mail/message/blog-get math help. For students use computer and internet for math study factor descriptive statistics, including frequency tables and bar graphs, were produced using SPSS. The new factor was named USE_COMP_STU. The researcher also estimated the composite reliability based on standardized factor loading and error variances CR .926. The researcher also checked the Kaiser-Guttman retention criteria of eigenvalues greater than 1.0 to identify if the factor was acceptable (Mayers et al., 2016). The students use computer and internet for math study factor met the retention criteria (eigenvalue=6.635) and accounted for 66.35% of the common variance (Table 2).

Table 2

Factor Analysis / Principal Component Analysis Computer Use

	Component	
	1	2
Use scientific calculator in math class		.500
Use calculator for math tests-student		.709
Use calculator to check math homework		.802
Use calculator to calculate math homework		.920
Use calculator for math lessons		.859
Use computer at school for math	.585	
Use spreadsheet program for math assignments	.801	
Use program to drill on math facts	.860	
Use program for new lessons on problem-solving	.850	
Use Internet to learn things for math class	.844	
Use calculator program for math class	.762	
Use graphing program for charts for math class	.847	
Use e-mail/message/blog-talk w/friends about math	.606	
Use e-mail/message/blog-get math help	.666	

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

Factor: Students Use of Calculator for Math Learning

To create students use of calculator for math learning factor, the researcher included five variables: use scientific calculator in math class, use calculator for math tests-student, use calculator to check math homework, use calculator to calculate math homework, and use calculator for math lessons. For students use of calculator for math learning factor descriptive statistics, including frequency tables and bar graphs, were produced using SPSS. The new factor was named USE_CALCULATOR. The researcher also estimated the composite reliability based on standardized factor loading and error variances CR .876. The researcher also checked the Kaiser-Guttman retention criteria of eigenvalues greater than 1.0 to recognize if the factor was acceptable (Mayers et al., 2005). The students use of calculator for math learning factor met the retention criteria (eigenvalue=1.872) and accounted for 18.72% of the common variance (Table 2).

Factor: Teachers' Qualification Graduate

To create teachers' qualification graduate factor, the researcher included three variables: grad major/minor mathematics education, grad major/minor mathematics, and grad major/minor other mathematics. For Teachers qualification graduate factor descriptive statistics, including frequency tables and bar graphs, were produced using SPSS. The new factor was named TCHR_QUAL_GRAD. The researcher also estimated the composite reliability based on standardized factor loading and error variances CR .962. The researcher also checked the Kaiser-Guttman retention criteria of eigenvalues greater than 1.0 to recognize if the factor was acceptable (Mayers et al., 2016). The Teachers' qualification graduate factor met the retention criteria (eigenvalue=3.189) and accounted for 31.89% of the common variance (Table 3).

Table 3

Factor Analysis / Principal Component Analysis Teachers' Qualification Graduate

	Component		
	1	2	3
Have you been awarded tenure by school where teach			.759
Hold valid regular/standard teaching certificate			.761
Undergrad major/minor mathematics education		.667	
Undergrad major/minor mathematics		.653	
Undergrad major/minor other mathematics		.730	
Undergrad major/minor education w/secondary		.786	
Grad major/minor mathematics education	.956		
Grad major/minor mathematics	.954		
Grad major/minor other mathematics	.927		

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.
a. Rotation converged in 4 iterations.

Factor: Teachers' Qualification Undergraduate

To create teachers' qualification undergraduate factor, the researcher included four variables: undergrad major/minor mathematics education, undergrad major/minor mathematics, undergrad major/minor other mathematics, and undergrad major/minor mathematics education w/secondary. For teachers' qualification undergraduate factor descriptive statistics, including frequency tables and bar graphs, were produced using SPSS. The new factor was named TCHR_QUAL_UNDERGRAD. The researcher also estimated the composite reliability based on standardized factor loading and error variances CR .803. The researcher also checked the Kaiser-Guttman retention criteria of eigenvalues greater than 1.0 to recognize if the factor was acceptable (Mayers et al., 2016). The teachers' qualification undergraduate factor met the retention criteria (eigenvalue=1.571) and accounted for 15.71% of the common variance (Table 3).

Factor: Teachers' Tenure and Certification

To create teachers' tenure and certification factor, the researcher included two variables: have you been awarded tenure by school where teach and hold valid regular/standard teaching certificate. For Teachers' tenure and certification factor descriptive statistics, including frequency tables and bar graphs, were produced using SPSS. The new factor was named TEACHING_QUALITY. The researcher also estimated the composite reliability based on standardized factor loading and error variances CR .732. The researcher also checked the Kaiser-Guttman retention criteria of eigenvalues greater than 1.0 to validate if the factor was acceptable (Mayers et al., 2016). The teachers' tenure and certification factor met the retention criteria (eigenvalue=1.170) and accounted for 11.70% of the common variance (Table 3).

Factor: Professional Development on Math Peer Collaboration

To create professional development on math peer collaboration factor, the researcher included ten variables: prof dev-math-worship or training, prof dev-math-conference, association, prof dev-math-observational visit, prof dev-math-mentor or peer observation, prof dev-math-discussion or study group, prof dev-math-teacher collaborative, prof dev-math-individual/collab research, prof dev-math-collage course, and prof dev-math-regular independent reading. For Professional development on math peer collaboration factor descriptive statistics, including frequency tables and bar graphs, were produced using SPSS. The new factor was named PORF_DEV_PEER_COLLAB. The researcher also estimated the composite reliability based on standardized factor loading and error variances CR .955. The researcher also checked the Kaiser-Guttman retention criteria of eigenvalues greater than 1.0 to recognize if the factor was acceptable (Mayers et al., 2016). The professional development on math peer collaboration factor met the retention criteria (eigenvalue=7.617) and accounted for 76.17% of the common variance (Table 4).

Table 4

Factor Analysis / Principal Component Analysis Professional Development Math

	Component	
	1	2
Prof dev-math theory or applications		.788
Prof dev-content standards in math		.787
Prof dev-curricular materials in math		.811
Prof dev-instructional methods for math		.873
Prof dev-effective use of manipulatives		.824
Prof dev-methods for assessing in math		.846
Prof dev-prep students district/state assessments		.741
Prof dev-math-workshop or training	.856	
Prof dev-math-conference, association	.830	
Prof dev-math-observational visit	.804	
Prof dev-math-mentor or peer observation	.819	
Prof dev-math-committee or task force	.817	
Prof dev-math-discussion or study group	.844	
Prof dev-math-teacher collaborative	.845	
Prof dev-math-individual/collab research	.832	
Prof dev-math-college course	.764	
Prof dev-math-regular independent reading	.821	

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

Factor: Professional Development on Math Instruction

To create Professional development on math instruction factor, the researcher included seven variables: prof dev-math theory or applications, prof dev-content standards in math, prof dev-curricular materials in math, prof dev-instructional methods for math, prof dev-effective use of manipulatives, methods for assessing in math, and prep students district/state assessments. For Professional development on math instruction factor descriptive statistics, including frequency tables and bar graphs, were produced using SPSS. The new factor was named PORF_DEV_INSTRUCT. The researcher also estimated the composite reliability based on standardized factor loading and error variances CR .931. The researcher also checked the Kaiser-Guttman retention criteria of eigenvalues greater than 1.0 to recognize if the factor was acceptable (Mayers et al., 2016). The Professional development on math instruction factor met the retention criteria (eigenvalue=3.783) and accounted for 37.83% of the common variance (Table 4).

Factor: Student Use of Computer in Math Class

To create student use of computer in math class factor, the researcher included seven variables: availability of computers for teachers/students, students use computer-practice or review math, students use computer extend math learning, students use computer-draw geometric shapes, students use computer-use graphing program, and students use computer-play math-games. For student use of computer in math class factor descriptive statistics, including frequency tables and bar graphs, were produced using SPSS. The new factor was named STU_CLASS_COMPT_USE. The researcher also estimated the composite reliability based on standardized factor loading and error variances CR .888. The researcher also checked the Kaiser-Guttman retention criteria of eigenvalues greater than 1.0 to recognize if the factor was acceptable (Mayers et al., 2016). The student use of computer in math class factor met the retention criteria (eigenvalue=3.449) and accounted for 34.49% of the common variance (Table 5).

Table 5

Factor Analysis / Principal Component Analysis Student Computer Use in Math

	Component
	1
Availability of computers for teacher/students	.526
Students use computer-practice or review math	.786
Students use computer-extend math learning	.841
Students use computer-draw geometric shapes	.806
Students use computer-use graphing program	.744
Students use computer-play math games	.803

Extraction Method: Principal Component Analysis.
a. 1 components extracted.

Plausible Values Regression Analysis

In order to determine the extent to which the components such as professional development use of computers or other technology, SES, parents education, students use of computer and internet for math study, students use of calculator for math learning, teachers qualifications, teachers tenure and certification, professional development on math peer collaboration, professional development on math peer collaboration, professional development on math instruction, and students usage of computer in math class on the 2013 eight grade mathematics NAEP, the researcher carried out plausible values regression analysis. Student's plausible values were determined by a comprehensive marginal maximum likelihood (MML) regression. The eight-grade mathematics achievement is represented by a combination of twenty values. The researcher used these twenty values, (MRPCM1, MRPCM2, MRPCM3, MRPCM5, MRPCM6, MRPCM7, MRPCM8, MRPCM8, MRPCM9, MRPCM, 10, MRPCM11, MRPCM12, MRPCM, 13, MRPCM14, MRPCM15, MRPCM16, MRPCM17, MRPCM18, MRPCM19, MRPCM20) as the dependent variables in all the regression except the multiple hierarchical in which used only one due to practical feasibility of analysis and limitations of using twenty dependent variables in SPSS.

For the purpose of the present study, the plausible values regression analysis calculated using AM statistical software beta version. This reports the overall *F*-statistics and corresponding *p*- value for the regression model as well as the significance of the contribution of each variable to the regression equation reported as *z*-scores. In this, the table-rows are formatted using one column for each of the following items: independent variables and the constant, the estimate, standard error, *z*-score, and the associated *p*-value. In addition to it, the table also shows the Root Mean Square Error (RMSE), R^2, and the effect size, calculated as, $f^2=R^2/(1-R^2)$, (Cohen, 2013). The Root Mean Square Error indicates the absolute fit of the model to the data- measuring the distance between the predicted value for the dependent variable and its actual value. It is one of the most commonly used measures of evaluating the predictions. Taking the square root of the mean of the squares allows the units of measure to be the same as the dependent variable.

Research Question 1

Is there a significant relationship between student socio-economic status and eighth-grade students' achievement on mathematics assessment? A Plausible values multiple regression analysis was carried out to determine the extent to which the variable SES predicted a student's mathematics achievements. There were 170102 observations collected after all the eliminations. For α=0.05, the overall test for the model was determined to be significant (R^2 = .130, F (1,81) =4604.25, p<.001). The model produced an R^2 value of .130; therefore, the variable SES in this model predicted 13% of the variance in the 2013 eight grade NAEP mathematics results. Since significance was found using this alpha level the null hypotheses, H_o1: there is no relationship between SES and 2013 NAEP 8th grade mathematics assessment results, was rejected. In addition, the independent variable made significant contributions to model at p<.001. The unstandardized coefficients for the variable SES were negative due to the direction of coding with higher scores corresponding to lower SES and fewer home resources. The negative unstandardized coefficients for SES that the lower the level of SES and the fewer home resources, the lower the predicted achievement on the 2013 eighth grade mathematics NAEP. Since f^2=0.149, a small effect size was indicated. Table 6 shows the results of the first step of the regression analyses.

Table 6

Plausible Values Regression-Step One

Parameter Name	Estimate	Standard Error	*z* Score	$p > \|z\|$
Constant	283.537	0.239	1186.017	0.000
Students' Socio-economic Status***	-14.004	0.206	-67.855	0.000
Root Mean Square Error	34.043			

***p<.001, **p<.01, *p<.05

R^2 = .130, F(1,81)=4604.25, p<.0001, f^2=0.149.

Research Question 2

Is there a significant relationship between students' SES, gender, and achievement on mathematics assessments? In step two of the plausible value multiple regression, student gender was added to the model for predicting students' mathematics achievement. There were 172983 observations after the selection of values. For α= 0.05, the overall test for the model was determined to be significant (R^2 = .130, F(2,80)=2296.98, p<.0001). The model produced an R^2 value of .130; therefore, when the variable student's gender was added to this model, it predicted 13% of the variance in the 2013 eighth-grade mathematics NAEP results. Therefore, the R^2 increased by 0% from the previous step. Since significance was found using this alpha level the null hypotheses, H_o2: there is no relationship between SES, gender and the eighth grade 2013 NAEP Mathematics Assessment was rejected. In addition, both independent variables made significant contributions to the model at p<.001. The negative unstandardized coefficient for the variable student gender indicated that the predicted achievement on the 2013 NAEP eighth grade mathematics test would be lower for females than males. The RMSE was slightly lower in Step 2 (34.040) than Step 1 (34.043) indicating less error between the predicted and actual values of the dependent variable; thus, this model had a better fit to the data than the prior model. Since f^2=0.149, a small effect size was indicated. Table 7 shows the results of step two of the regression analyses.

Table 7

Plausible Values Regression-Step Two

Parameter Name	Estimate	Standard Error	*z* Score	$p > \|z\|$
Constant	284.730	0.506	562.599	0.000
Students' Socio-economic Status ***	-14.006	0.206	-67.925	0.000
Student Gender***	-0.801	0.284	-2.819	0.000
Root Mean Square Error	34.040			

***p<.001, **p<.01, *p<.05

R^2 = .130, $F(2,80)$=2296.98, p<.0001, f^2=0.149.

Research Question 3

Is there a significant relationship between SES, gender, professional development of computer and other technology, parents' education, teachers' tenure and certification, professional development on math instruction and eight grade students' achievement on the NAEP mathematics assessment? In step three of the plausible value multiple regression, remaining five factors were added to the model. As discussed in chapter 3, these factors were assumed to be having greater role in predicting the students' achievement. Making a combination of these variables, works the filtering job the best. There were 153660 observations in professional development of computer and other technology, 170102 in observations parents' education, 153660 observations in teachers' educational qualification, teachers' tenure and certification, and professional development on math instruction.

For α= 0.05, the overall test for the model determined to be significant (R^2 = .175, F(13,68)=485.061, p<.001). Although all variables are determined to be significant only the p-value of professional development of computer or other technology is mentioned here, as it is important for the use of present study. The model produced an R^2 value of .175; therefore, when the professional development of computer or other technology factors were added to this model, it predicted 17.5% of the variance in the 2013 eight grade mathematics NAEP results. The R^2 increased by .45% from the previous steps. Since significance was found using this alpha level the null hypotheses, H_o3: there is no relationship between SES, gender, professional development of computer and other technology, parents' education, teachers' tenure and certification, professional development on math instruction and eight grade students' achievement on the NAEP mathematics assessment was rejected. In addition, all independent variables made significant contributions to the model at p<.001. However, at this step, the factor professional development of computer and other technology made significant contributions at p<.05. The positive unstandardized coefficient for the factor professional development of computer and other technology indicated that teachers who frequently attended educational technology professional development predicted the higher achievement of their students on the 2013 eight grade mathematics NAEP. The RMSE was lower in Step 3 (32.939) than Step 2 (34.040) indicating less error between the predicted and actual values of the dependent variable; thus, this model had a better fit to the data than the prior model. Since f^2=0.212, a moderate effect size was indicated. Table 8 shows the results of step three of the regression analyses.

Table 8

Plausible Values Regression-Step Three

Parameter Name	Estimate	Standard Error	*z* Score	*p* > |*z*|
Constant	283.733	1.043	272.019	0.000
Students' Socio-economic Status ***	-11.570	0.229	-50.568	0.000
Professional dev-use of computers or other technology***	1.506	0.367	4.107	0.000
Student Gender***	-1.927	0.36	-5.347	0.000
Students parents education***	1.348	0.174	7.748	0.000
Teaachers tenure and certification**	0.971	0.344	2.822	0.005
Professional development on maths instruction***	-1.549	0.391	-3.964	0.000
Root Mean Square Error	32.939			

***p<.001, **p<.01, *p<.05

R^2 = .175, $F(13,68)$=485.061, p<.001.

t -Tests

The researcher conducted a final regression *t*-tests on all the selected independent variables within the model. It was found that each independent variable contributed significantly and uniquely to the model: student gender $t(80)$=-240.57376, p<0.001; prof dev-use of computer or other technology $t(80)$=-205.84508, p<0.001; Socio-economic status $t(80)$=-286.62209, p<0.001; student parents' education $t(80)$=-258.92511, p<0.001, students use of computer and internet for math study $t(80)$=-277.61196, p<0.001, students use of calculator for math learning $t(80)$=-264.50948, p<0.001, teachers qualification graduate $t(80)$=-255.73941, p<0.001, teachers qualification undergraduate, $t(80)$=-254.58778, p<0.001, teachers tenure and certification $t(80)$=-255.84306, p<0.001, professional development on math peer collaboration $t(80)$=-258.08787, p<0.00, Prof development on math instruction *t*(80)=-335.01782, *p*<0.00, and students use of computer in math class *t*(80)=-282.77033, *p*<0.001 (Table 9).

Table 9

Independent t-tests for Constant and Parameters Final Step Regression

Parameter Name	Estimate	Difference	Standard Error	df	*T* Value	Prob>*t*
Constant	283.733					
Student Gender	-1.518	-285.252	1.186	80	-240.574	0.000
Prof dev-use of computer or other technology	1.506	-282.227	1.371	80	-205.845	0.000
Socio-economic Status	-11.570	-295.304	1.030	80	-286.622	0.000
Student Parents education	1.348	183.733	1.091	80	-258.925	0.000
Student use computer and internet for maths study	-10.276	283.733	1.059	80	-277.612	0.000
Student use of calculator for maths learning	2.776	-280.957	1.062	80	-264.509	0.000
Teachers qualification graduate	-1.029	-284.762	1.113	80	-256.739	0.000
Teachers qualification undergraduate	0.371	-284.104	1.116	80	-254.588	0.000
Teachers tenure and certification	0.971	-282.762	1.105	80	-255.843	0.000
Prof development on maths peer collaboration	-0.575	-284.308	1.102	80	-258.088	0.000
Prof development on maths instruction	-1.549	-285.262	0.852	80	-335.018	0.000
Students use of computer in math class	-0.273	-284.007	1.004	80	-282.770	0.000

Though not stated, the final Step Plausible Regressions Filtered by Race/Ethnicity Subgroups

Final Step Plausible Regressions Filtered by Race/Ethnicity Subgroups

In the 2013 NAEP dataset, the variable student race/ethnicity (SRACE10) was obtained from school records and reported in six mutually exclusive categories: White, Black, Hispanic, Asian Americans/Pacific Islanders, Native Americans/Alaskan Native, and Unclassified. After dummy coding each of the first for, the researcher conducted the analysis. To enable the analyses on these race/ethnic subgroups, the researcher also employed a filter in AM and ran the final step of the regression, four separate times.

Full Model Filtered Race/Ethnicity Subgroup: White

For the NAEP reported subgroup of white students, is there a significant connection between teachers' professional development use of computer and other technology and student mathematics achievement on the NAEP assessment? In order to administer the last phase of the regression independently for the NAEP subgroup of White students, a filter was used in the AM Beta software. There were 85,590 observations after selection. For $\alpha = 0.05$, the overall test for the model determined to be significant $R^2 = 0.116$, $F(12,66)=153.197$, $p<.001$. The model produced an R^2 value of .116; thus, the independent variables predicted 11.6% of the variance in the 2013 eighth grade mathematics NAEP results. The R^2 value for the subgroup of White students denotes a decrease of 5.9%, from the R^2 of the whole sample in the final stage of the regression. Because significance was noted using this alpha level, there is no relationship between professional development on math instruction and the eighth grade 2013 NAEP mathematics assessment for the subgroup of White students in the sample and was rejected. In addition, the five independent variables, socio-economic status, prof dev-use of computer or other technology, student gender, student parents' education, and teachers' tenure and certification made significant contributions to the model at $p<.001$. The RMSE for this subgroup's model (31.101) was lower than the unfiltered model for the entire sample (32.939) showing less error between the predicted and actual values of the dependent variable. It means that the model for subgroup White fits its data better than the model for the whole sample. Since f^2=0.131, a small effect size was indicated. Table 10 shows the results of the filtered final step of the regression analysis for the white student subgroup.

Table 10

Plausible Values Regression – Filter Subgroup: White

Parameter Name	Estimate	Standard Error	*z* Score	*p* > |*z*|
Constant	288.469	1.006	286.886	0.000
Students' Socio-economic Status ***	-11.236	0.342	-32.859	0.000
Professional dev-use of computers or other technology***	1.190	0.357	3.333	0.001
Student Gender***	-1.990	0.337	-5.904	0.000
Students parents education***	2.883	0.239	12.048	0.000
Teaachers tenure and certification***	1.369	0.403	3.395	0.001
Professional development on maths instruction***	-0.756	0.397	-1.906	0.057
Root Mean Square Error	31.101			

***$p<.001$, **$p<.01$, *$p<.05$

$R^2 = .116$, $F(12,66)=153.197$, $p<.001$, $f^2=0.131$.

For the NAEP race/ethnicity subgroup of white students, *t*-tests were conducted on the independent variables in the plausible value regression model. The seven independent variables_Socio-economic status $t(77)= -299.705$, $p<0.001$; prof dev-use of computer or other technology $t(77)= -287.278$, $p<0.001$; student gender $t(77)= -290.459$, $p<0.001$; student parents' education $t(77)= -285.586$, $p<0.001$; teachers tenure and certification *t*(77)= -287.099, *p*<0.001; prof development on math instruction *t*(77)= -289.225, *p*<0.001. The results of the *t*-tests are located in Table 11.

Table 11

Independent t-test- Filter Subgroup: White

Parameter Name	Estimate	Difference	Standard Error	df	*T* Value	Prob>*t*
Constant	288.469					
Student Gender	-1.9898	-290.459	1.186	77	-244.967	0.000
Prof dev-use of computer or other technology	1.190	-287.278	1.33991	77	-217.8647	0.000
Socio-economic Status	-11.236	-299.705	1.036	77	-289.368	0.000
Student Parents education	2.883	-285.586	1.092	77	-261.446	0.000
Student use computer and internet for maths study	-8.2599	-296.729	1.086	77	-273.202	0.000
Student use of calculator for maths learning	1.970	-286.498	1.093	77	-262.096	0.000
Teachers qualification graduate	-1.350	-289.819	1.048	77	-276.465	0.000
Teachers qualification undergraduate	0.062	-288.407	1.115	77	-258.647	0.000
Teachers tenure and certification	1.370	-287.099	1.098	77	-261.514	0.000
Prof development on maths peer collaboration	-0.903	-289.372	1.074	77	-269.394	0.000
Prof development on maths instruction	-0.756	-289.225	0.811	77	-356.592	0.000
Students use of computer in math class	0.070	-286.399	0.949	77	-304.009	0.000

Full Model Filtered Race/Ethnicity Subgroup: Black

For the NAEP reported subgroup of black students, is there a significant relationship between teachers' professional development use of computer and other technology and student mathematics achievement on the NAEP assessment? In order to run the final step of the regression exclusively for the NAEP subgroup of Black students, a filter was employed in the AM Beta Statistics software. There were 25, 577 observations after the selection. For α= 0.05, the overall test for the model determined to be significant (R^2 = 0.127, $F(12,62)$=93.256, p<.001. The model produced an R^2 value of .127; thus, the independent variables predicted 12.7% of the variance in the 2013 eighth grade mathematics NAEP results. The R^2 value for the subgroup of black students represents a decrease of 4.8%, from the R^2 of the unfiltered final step of the regression. Since significance was found using this alpha level the null hypotheses, there is no relationship between student parents' education, Prof development on math instruction, prof dev-use of computer or other technology and the eighth grade 2013 NAEP Mathematics Assessment for the subgroup of Black students in the sample and was rejected.

In addition, all three independent variables made significant contributions to the model, Socio-economic status (p<.001), student gender(p<.05), teachers' tenure and certification (p<.05). The RMSE for this subgroup's model (31.322) was lower than the unfiltered model (32.939) indicating less error between the predicted and actual values of the dependent variable. Thus, the model for this subgroup fits its data better than the model for the entire sample. Since f^2=0.131, a small effect size was indicated. Table 12 shows the results of the filtered final step of the regression analysis for the black student subgroup.

Table 12

Plausible Values Regression – Filter Subgroup: Black

Parameter Name	Estimate	Standard Error	*z* Score	*p* > |*z*|
Constant	263.324	1.865	141.205	0.000
Students' Socio-economic Status ***	-6.803	0.454	-14.971	0.000
Professional dev-use of computers or other technology	0.473	0.643	0.737	0.461
Student Gender*	1.677	0.724	2.314	0.020
Students parents education	0.387	0.365	1.062	0.288
Teachers tenure and certification*	1.026	0.507	2.022	0.043
Professional development on maths instruction	-0.837	0.716	-1.169	0.242
Root Mean Square Error	31.322			

****p*<.001, ***p*<.01, **p*<.05

R^2 = .116, $F(12,66)=153.197$, $p<.001$, $f^2=0.131$.

For the NAEP race/ethnicity subgroup of Black students, *t*-tests were conducted on the independent variables in the plausible value regression model. Each independent variable also made a significant unique contribution to the model: Socio-economic status $t(73)= -270.127$, $p<0.001$; prof dev-use of computer or other technology $t(73)= -262.851$, $p<0.001$; student gender $t(73)= -261.647$, $p<0.001$; student parents' education $t(73)= -262.937$, $p<0.001$; teachers tenure and certification $t(73)= -262.298$, $p<0.001$; Prof development on math instruction $t(73)= -264.161$, $p<0.01$. The results of the *t*-tests are in Table 13.

Table 13

Independent t-test- Filter Subgroup: Black

Parameter Name	Estimate	Difference	Standard Error	*df*	*T* Value	Prob>*t*
Constant	263.324					
Student Gender	1.677	-261.647	2.312	73	-113.180	0.000
Prof dev-use of computer or other technology	0.473	-262.851	2.395	73	-109.743	0.000
Socio-economic Status	-6.803	-270.127	1.976	73	-136.708	0.000
Student Parents education	0.387	-262.937	1.981	73	-132.762	0.000
Student use computer and internet for Maths study	-9.382	-272.706	1.939	73	-140.635	0.000
Student use of calculator for Maths learning	0.480	-262.844	1.769	73	-148.551	0.000
Teachers qualification graduate	-0.536	-263.860	1.873	73	-140.816	0.000
Teachers qualification undergraduate	-0.606	-263.930	1.910	73	-138.197	0.000
Teachers tenure and certification	1.026	-262.298	2.007	73	-130.667	0.000
Prof development on maths peer collaboration	-0.375	-263.298	1.935	73	-136.297	0.000
Prof development on maths instruction	-0.837	-264.161	1.572	73	-168.078	0.000
Students use of computer in math class	-0.390	-263.715	1.883	73	-140.029	0.000

Full Model Filtered Race/Ethnicity Subgroup: Hispanic

For the NAEP reported subgroup of Hispanic students, is there a significant relationship between teachers' professional development use of computer and other technology and student mathematics achievement on the NAEP assessment? In order to run the final step of the regression exclusively for the NAEP subgroup of Hispanic students, a filter was employed in the AM Beta Software. There were 28,334 observations after the list-wise elimination of missing values. For α= 0.05, the overall test for the model determined to be significant (R^2 = 0.130, $F(12,63)$=78.9273, p<.001). The model produced an R^2 value of .130; thus, the independent variables predicted 13% of the variance in the 2013 eighth grade mathematics NAEP results. The R^2 value for the subgroup of Hispanic students represents a decrease of 13%, from the R^2 of the unfiltered final step of the regression. Since significance was found using this alpha level the null hypotheses, there is no relationship between prof development on math instruction (p<.05) and the eighth grade 2013 NAEP Mathematics Assessment for the subgroup of Hispanic students in the sample and was rejected.

In addition, other independent variables, socio-economic status (p<.01), prof dev-use of computer or other technology(p<.05), student gender(p<.05), student parents' education (p<.01), teachers' tenure and certification (p<.05), made significant contributions to the model. The RMSE for this subgroup's model (31.802) was lower than the unfiltered model (32.939) indicating less error between the predicted and actual values of the dependent variable. Thus, the model for this subgroup fits its data better than the model for the entire sample. Since f^2=0.149, a small effect size was indicated.

Table 14 shows the results of the filtered final step of the regression analysis for the Hispanic student subgroup.

Table 14

Plausible Values Regression – Filter Subgroup: Hispanic

Parameter Name	Estimate	Standard Error	*z* Score	*p* > |*z*|
Constant	273.931	1.699	161.229	0.000
Students' Socio-economic Status ***	-7.313	0.435	-16.830	0.000
Professional dev-use of computers or other technology*	1.265	0.605	2.090	0.037
Student Gender*	-1.273	0.638	-1.994	0.046
Students parents education***	-1.263	0.320	-3.946	0.000
Teachers tenure and certification*	1.026	0.507	2.022	0.043
Professional development on maths instruction*	-0.555	0.724	-0.766	0.444
Root Mean Square Error	31.802			

***p<.001, **p<.01, *p<.05

R^2 = .130, $F(12,63)$=78.9273, p<.001, f^2 =.149

For the NAEP race/ethnicity subgroup of Hispanic students, *t*-tests were conducted on the independent variables in the plausible value regression model. Each independent variable also made a significant, unique contribution to the model: Socio-economic status $t(74)$= -281.244, p<0.001; prof dev-use of computer or other technology $t(74)$= -272.666, p<0.001; student gender $t(74)$= -275.203, p<0.001; student parents' education $t(74)$= -275.193, p<0.001; teachers tenure and certification $t(74)$= -272.413, p<0.001; Prof development on maths instruction $t(74)$= -274.485, p<0.01. The results of the t-tests are in Table 15.

Table 15

Independent t-test- Filter Subgroup: Hispanic

Parameter Name	Estimate	Difference	Standard Error	df	*T* Value	Prob>*t*
Constant	273.931					
Student Gender	-1.27	-275.203	2.029	74	-135.604	0.000
Prof dev-use of computer or other technology	1.265	-272.666	2.211	74	-123.302	0.000
Socio-economic Status	-7.320	-281.244	1.818	74	-154.725	0.000
Student Parents education	-1.263	-275.193	1.702	74	-161.677	0.000
Student use computer and internet for maths study	-10.166	-284.097	1.655	74	-171.711	0.000
Student use of calculator for maths learning	2.029	-271.902	1.679	74	-161.952	0.000
Teachers qualification graduate	0.720	-273.211	1.782	74	-153.324	0.000
Teachers qualification undergraduate	-0.845	-274.776	1.716	74	-160.090	0.000
Teachers tenure and certification	1.518	-272.413	1.717	74	-158.633	0.000
Prof development on maths peer collaboration	-1.267	-275.188	1.728	74	-159.297	0.000
Prof development on maths instruction	-0.555	-274.485	1.374	74	-199.843	0.000
Students use of computer in math class	0.429	-273.502	1.727	74	-158.372	0.000

Full Model Filtered Race/Ethnicity Subgroup: Asian American/Pacific Islander

For the NAEP reported subgroup of Asian American/Pacific Islander students, is there a significant relationship between teachers' professional development use of computer and other technology and student mathematics achievement on the NAEP assessment? In order to run the final step of the regression exclusively for the NAEP subgroup of Asian American/Pacific Islander students, a filter was employed in the AM Beta Statistics software. There were 6,340 observations after the list-wise elimination of other values.

For α= 0.05, the overall test for the model determined to be significant (R^2 = 0.171, F(12,58)=31.594, p<.001, f^2 = .206). The model produced an R^2 value of .171; thus, the independent variables predicted 17.1% of the variance in the 2013 eighth grade mathematics NAEP results. The R^2 value for the subgroup of Asian American/Pacific Islander students represents a decrease of .4%, from the R^2 of the unfiltered final step of the regression. Since significance was found using this alpha level the null hypotheses, there is no relationship between prof dev-use of computer or other technology, student gender, student parents' education, teachers' tenure and certification, Prof development on math instruction and the eighth grade 2013 NAEP Mathematics Assessment for the subgroup of Asian American/Pacific Islander students in the sample and was rejected. In addition, only one independent variable made significant contributions to the model, SES (p<.001), however the education technology professional development factor was not found to be significant for this subgroup. The RMSE for this subgroup's model (34.041) was higher than the unfiltered model (32.939) indicating more error between the predicted and actual values of the dependent variable. Thus, the model for this subgroup fits its data more poorly than the model for the entire sample. Since f^2=.206, a medium effect size was indicated. Table 16 shows the results of the filtered final step of the regression analysis for the Asian American/Pacific Islander student subgroup.

Table 16

Plausible Values Regression – Filter Subgroup: Asian American/Pacific Islander

Parameter Name	Estimate	Standard Error	*z* Score	$p > \|z\|$
Constant	309.158	3,394	91.082	0.000
Students' Socio-economic Status ***	-12.382	0.934	-13.257	0.000
Professional dev-use of computers or other technology*	0.741	1.084	0.683	0.0494
Student Gender*	-2.876	1.456	-1.976	0.048
Students parents education*	-1.626	0.779	-2.088	0.037
Teachers tenure and certification	o.625	0.968	0.646	0.519
Professional development on maths instruction	-0.590	1.159	-0.509	0.611
Root Mean Square Error	34.041			

***p<.001, **p<.01, *p<.05

R^2 = .171, F(12,58)=31.594, p<.001, f^2 =.206

For the NAEP race/ethnicity subgroup of Asian American/Pacific Islander students, t-tests were conducted on the independent variables in the plausible value regression model. Each independent variable also made a significant unique contribution to the model: Socio-economic status t(69)= -321.540, p<0.001; prof dev-use of computer or other technology t(69)=-308.417, p<0.001; student gender t(69)=- 309.033, p<0.001; student parents' education t(69)= -310.784, p<0.001; teachers tenure and certification t(69)= -308.532, p<0.001; Prof development on maths instruction t(69)= -309.748, p<0.01. The results of the *t*-tests are in Table 17.

Table 17

Independent t-test- Filter Subgroup: Asian American/Pacific Islander

Parameter Name	Estimate	Difference	Standard Error	df	*T* Value	Prob>*t*
Constant	309.158					
Student Gender	-2.876	-309.033	4.373	69	-71.357	0.000
Prof dev-use of computer or other technology	0.741	-308.417	4.208	69	-73.296	0.000
Socio-economic Status	-12.382	-321.540	3.633	69	-68.500	0.000
Student Parents education	-1.626	-310.784	3.528	69	-88.085	0.000
Student use computer and internet for maths study	-9.901	-319.058	3.327	69	-95.889	0.000
Student use of calculator for maths learning	3.878	-305.279	3.464	69	-88.117	0.000
Teachers qualification graduate	-2.414	-311.572	3.842	69	-81.090	0.000
Teachers qualification undergraduate	1.206	-307.951	3.331	69	-92.438	0.000
Teachers tenure and certification	0.625	-308.532	3.466	69	-89.019	0.000
Prof development on maths peer collaboration	-0.510	-309.669	3.357	69	-92.202	0.000
Prof development on maths instruction	-0.590	-309.748	3.096	69	-100.040	0.000
Students use of computer in math class	-0.229	-309.386	3.484	69	-88.015	0.000

Comparison of Subgroup Results

The researcher compared the filtered regression models for each race/ethnic subgroup (table 4.19) to determine differences in the coefficients used to predict student's mathematics achievement. The negative coefficient indicates it was influential on the effects of students' mathematics achievements. The effect of SES was found to be largest for the Asian American/Pacific Islanders race/ethnic subgroup of students (-12.38) and the least for Black race/ethnic subgroup of students (-6.800). Student gender was significant for only three of the four reported race/ethnic subgroups. Parent education was significant both in Hispanic and Asian race//ethnic subgroups. The teachers' professional development in math instruction factor had nominal influence on test results for all the four race/ethnic subgroups.

Table 18

Comparison of Race Subgroups Correlation Coefficients

Race Subgroup	N	Constant	Independent Variable Correlation Coefficients					
			SES	Prof. Dev. Cop.	Gender	Parents Edu.	Teacher Tenure	Prof. Math Instru.
White	85,590	288.469	-11.24	-	-1.99	-	-	-0.756
Black	25,577	263.324	-6.800	-	-	-	-	-0.837
Hispanic	28,334	273.931	-7.313	-	-1.273	-1263	-	-0.555
Asian	6,340	309.158	-12.38	-	-2.876	-1.626	-	-0.59

Coefficients that were not significant at α= 0.05 were not reported
Regression not run for this subgroup: American Indian/Alaskan Native and unclassified.
Dependent Variable: Plausible NAEP math value #1 (composite)

Hierarchical Regression

To check if the selected variables of the researcher's interest explain a statistically significant amount of variance in the dependent variable after accounting for other variables. The researcher ran a hierarchical regression analysis with seven steps. The data satisfies assumptions of normality, linearity, tolerance (multicollinearity), and homoscedasticity (histogram, P-P plot, and scatter plot).

The model summary of the analysis showed that the multiple correlation coefficient (*R*), using all the predictors simultaneously, the model 1 is .352 (R^2 =.124) and Adjusted R square (.124), model 2 is .352 (R^2 =.124) and Adjusted R square (.124), model 3 is .357 (R^2 =.127) and Adjusted R square (.127), model 4 is .357 (R^2 =.127) and Adjusted R square (.127), model 5 is .361 (R^2 =.130) and Adjusted R square (.130), model 6 is .362 (R^2 =.131) and Adjusted R square (.131), and model 7 is .362 (R^2 =.131) and Adjusted R square (.131). The Durbin-Watson is 1.613 (well within 1 and 2). Meaning that 12%, 12%, 13%, 13%, 13%, 13%, and 13% of the variance in the 2013 NAEP eighth grade Math Achievement can be predicted from SES, gender, race, professional dev-use of computers or other technology, students' parents education, teachers tenure and certification, and professional development on maths instruction (see Table 19).

Table 19

Hierarchical Regression Model Summary

Model	*R*	R^2	Adjusted R^2	Durbin-Watson
1	0.352[a]	0.124	0.124	
2	0.352[b]	0.124	0.124	
3	0.357[c]	0.127	0.127	
4	0.357[d]	0.127	0.127	
5	0.361[e]	0.13	0.13	
6	0.362[f]	0.131	0.131	
7	0.362[g]	0.131	0.131	1.613

a. Predictors: (Constant), Students Socio-Economic Status
b. Predictors: (Constant), Students Socio-Economic Status, Gender
c. Predictors: (Constant), Students Socio-Economic Status, Gender, School race
d. Predictors: (Constant), Students Socio-Economic Status, Gender, School race, Prof dev-use of computers or other technology
e. Predictors: (Constant), Students Socio-Economic Status, Gender, School race, Prof dev-use of computers or other technology, Students Parents education
f. Predictors: (Constant), Students Socio-Economic Status, Gender, School race, Prof dev-use of computers or other technology, Students Parents education, Teachers Tenure
g. Predictors: (Constant), Students Socio-Economic Status, Gender, School race, Prof dev-use of computers or other technology, Students Parents education, Teachers Tenure, Professional Development on maths instruction.
h. Dependent Variable: Plausible NAEP math value#20 (composite)

The ANOVA table showed that model 1 F (153635) =21750.370 p=.000, model 2 F (153,634) =10882.241 p=.000, model 3 F (153,633) =7468.962 p=.000, model 4 F (153,632) =5611.696 p=.000, model 5 F (153,631) =4609.348 p=.000, model 6 F (153,630) =3862.175 p=.000, and model 7 F (153,629) =3319.302 p=.000. This indicates that the combination of the predictors predicts the 2013 NAEP eighth grade Math Achievement (Table 4.21). The coefficients table shows that the SES, gender, race, professional dev-use of computers or other technology, students' parents education, teachers tenure and certification, and professional development on maths instruction are adding to the prediction. The data also indicates that the other six variables SES, gender, race, students' parents' education, teachers' tenure and certification, and professional development on math instruction are significant to the prediction of the 2013 NAEP eighth grade Math Achievement.

Table 20

Anova

Model	*df*	*F*	*p*
1	153635	21750.37	0.000^{***}
2	153634	10882.241	0.000^{***}
3	153633	7468.962	0.000^{***}
4	153632	5611.696	0.000^{***}
5	153631	4609.348	0.000^{***}
6	153630	3862.175	0.000^{***}
7	153629	3319.302	0.000^{***}

***p<.001, **p<.01, *p<.05

The standardized beta coefficients of SES β=-12.539, t=-.138.490, p=.000, gender β=-.395, t=-2.270, p=.023, race β=-1.601, t=-.23.745, p=.001, professional dev-use of computers or other technology β=-.426, t=-5.526, p=.001, students' parents education β=1.983, t=22.602, p=.001, teachers tenure and certification β=-.912, t=-.10.486, p=.001, and professional development on maths instruction is β=-.908, t=-7.353, p=.001. The data analysis shows that all variables were significantly correlated with the 2013 NAEP eighth grade Math Achievement. They contribute to the multiple regression predicting the 2013 NAEP eighth grade Math Achievement (Table 4.22).

Table 21

Coefficients Table

	β	t	p
SES	-12.539	-138.49	0.000
Gender	-0.395	-2.27	0.023
Race	-1.601	-23.745	0.001
Professional dev-use of computer or other technology	-0.426	-5.526	0.001
Students' parents' education	1.983	22.602	0.001
Teacher tenure and certification	-0.912	-10.486	0.001
professional development on maths instruction	-0.908	-7.353	0.001

***p<.001, **p<.01, *p<.05, Dependent Variable: Plausible NAEP math value#20 (composite)

CHAPTER 5 FINDINGS

In the present chapter, the study discusses the implications of the findings and relates them to the theoretical framework suggested in chapter II. This is followed by a short discussion on the limitations of the present study along with the areas of recommendation for further research. The study concludes with few notes on the implications for practitioners of technology professional development in school education.

In a study carried out by Cheung & Slavin (2013), the researchers point out that the effective application of numerous educational technologies helps to deliver learning content and makes the learning process more effective on improving learning objectives in K-12 classrooms. It includes positive effects on K-12 students' mathematics achievement. Teachers of different age and service categories differ statistically with respect to their current knowledge in the ways in which technology can be used in the teaching-learning process at schools (Beşoluk et al., 2010). This makes teachers professional development in their use of technology in classroom an inevitable concern for all stakeholders. So, teachers must adequately receive training to use technology for instruction (Beşoluk et al., 2010).

The researcher realizes that there are few significant studies linked to the NAEP 2013 eighth grade mathematics achievement and teachers' professional development in technology usage. In this correlational study, the researcher selected the independent variables and analyzed them with the dependent variable: 2013 NAEP eighth grade mathematics achievements.

The researcher investigated the following questions:

1. Is there a significant relationship between students' socioeconomic status, and 8th-grade students' achievement in mathematics assessment?
2. Is there a significant relationship between students' socioeconomic status, gender, and 8th-grade students' achievement in mathematics assessment?
3. Is there a significant relationship between student socio-economic status, gender, teachers' educational technology professional development, parents' education, teachers' tenure and certification, professional development in math instruction, and 8th-grade students' achievement in mathematics assessment for four of the NAEP-identified race/ethnic subgroups: White, Black, Hispanic, and Asian Americans/Pacific Islanders?

Null Hypothesis

H_o1: There is no significant relationship between SES and 8th-grade students' achievement in mathematics assessments.

H_o2: There is no significant relationship between SES, gender, and 8th-grade students' achievement on mathematics assessments.

H_o3: There is no significant relationship between SES, gender, teachers' educational technology professional development, parents' education, teachers' tenure and certification, professional development on math instruction, and 8th-grade students' achievement in mathematics assessment.

In addition, there were four hypotheses, one for each of the subgroups: White, Black, Hispanic, and Asian American/Pacific Islander.

In this non-experimental quantitative study, the researcher used data from the 2013 eighth grade mathematics achievement of NAEP restricted dataset. For the statistical analysis of this study, the researcher created factors following the other researchers in this area of research. Based on the results of the analysis conducted, the following observations are noted by way of major findings:

- It is observed that teachers who had professional development in the use of computer and other technologies had students with higher achievement in their mathematics assessments.
- It was also observed that the higher the level of socio-economic status of the family of students, the higher their achievement score as well in the mathematics assessment. This was found to be true in all the four NAEP recognized subgroups of race/ethnicity.
- It was understood from the hierarchical regression that there is a positive correlation between teachers' technology professional development program and students' math achievement.
- Higher levels of SES was reported for the subgroups of White and Asians resulting in higher levels of mathematics achievements.
- Considering the overall performances of students, the males outperformed females in mathematics achievements. Although the difference is not large, it was found to be true for all the four of the NAEP recognized subgroups of race/ethnicity: White, Black, Hispanic, and Asian American/Pacific Islander.

Discussion

This study analyzed the effects of teachers' technology professional development on the NAEP 2013 eighth class mathematics achievements, with special attention on teachers TPACK self-efficacy theoretical framework. To learn mathematics, technology, in the form of tools can help students with problem solving, aid exploration of mathematical concepts, offer dynamically linked representations of ideas and inspire general metacognitive abilities like planning, checking, etc. (Pierce et al., 2007). With the growing investment in delivering information technology to support teaching and learning mathematics, it is important to understand how well students perform in their assessments having teachers with professional development in computer and other technology. Grounded in research, scholars recognize that students' academic performance is based on a function of many interrelating factors, and technology is very well related to socio-economic situation of students (Sun & Metros, 2011).

There is enough literature documented describing the effects of SES and students' mathematics achievement. Findings of numerous research show that parental SES directly impacts students' achievement (Alordiah, Akpadaka & Oviogbodu, 2015; Lee, Zhang, & Stankov, 2019; Perry & McConney, 2010). It indicated that sufficient attention is to be paid into the disparity existing among students based on their socio-economic status. The findings revealed that among the factors examined, the strongest correlations exist between SES and students' performance. Students of parents with higher SES did better in their mathematics because of the increased availability of family resources. This affirms the extensive literature review suggesting that family into which a child is born will turn out to be the best predictor of the students' learning achievement.

In order to explore the latest trend of SES' relation to the eight grade NAEP mathematics achievements, this study analyzed the 2013 dataset. The current study examined the association some of the home resources, which define the scope of SES. In an effort to broaden the scope of SES, the researcher included items such as computer at home, internet access, books, magazines, independent bedroom and bathrooms, private washing machines, etc., under the umbrella of SES. The ideas posed by earlier researchers are said to be true in the current analysis in general and in all the four ethnic/race subgroups in particular. The analysis found that over 14% of the variance in the NAEP are related to the SES of a student and must be in the focus of attention for all educational initiatives.

In the unstandardized regression coefficient of the hierarchical regression, there is an increase (positive) of -.426 unit (level #6) in the outcome variable on every one unit of increase in the predictor variable. This correlational outcome reiterates that extra use of teachers' professional development program on computers and other technologies are positively affecting the students' math achievement.

As already mentioned in chapter 2, there is extensive research describing the trends in gender relation and various students' groups in mathematics achievements based on NAEP data (McGraw, Lubienski & Strutchens 2006). Considering this fact, the present study focused on the gender relation to eighth grade mathematics achievements. Having analyzed the 2013 NAEP data sets, the researcher affirms the previous findings that gender at middle school level is significantly related to mathematics achievement. Considering the gender issue, Meggiolaro (2018) studied the Italian sub-set of the PISA and concluded that the ICT use in relationship to mathematics achievement is found to be weaker for girls in comparison to boys. The current study confirms this finding in the race/ethnicity subgroups analysis of the 2013 NAEP eighth grade data set. The predicted scores for white males were 1.039%, African American males 1.627%, Hispanic males

1.87% and Asian males 2.135% were higher than girls of the same subgroups if other independent variables were held constant. This further affirms the findings of Falch & Naper (2013) that boys outperform girls in more competitive exams especially when they are not conducted and assessed by their own teachers in respective subjects. Educators at all levels must give the best priority to break this stereotype and social bias attached the lower achievement of female students in mathematics achievement. Infusing educational technologies in an efficient way can help to achieve this end.

In exploring the use of educational technology and teachers, the researcher used TPACK theoretical framework for this study (Mishra & Kohler, 2006). This provides a deeper understanding of the use of technology, pedagogy, and content for the better TPACK self-efficacy to create a progressive and sustainable technology infused teaching learning process (Saudelli & Ciampa, 2016). In most of the studies reviewed by the researcher, technology is an important sustainable and supportive aid in the classroom if used effectively by teachers (Lau et al, 2013; Varol, 2013; Umar & Hassan, 2015; Maksimovic & Dimic, 2016; Beşoluk, et al, 2010). To achieve higher teachers' self-efficacy in relation to their ability to handle technology tools, professional development is a significant factor. This has significant influence on their attitude towards technology incorporation in classroom teaching (Rohaan, Taconis, & Jochems, 2012).

Nearly all states and territories have adopted the CCSS standards, which focus on technology requirements and mandate that states provide cost-effective access to relevant educational technologies. To achieve these expectations, educational leaders must monitor current instructional practices and advise policy makers to redesign a sustainable futuristic education program to take advantage of the potential of technology.

Considering all these, the present study holds national implications that can assist education administrators and policy makers who intend to make use of the updated educational technologies in classroom teachings. The present classrooms and all syllabi are infused with numerous advanced educational technologies to assist teachers for a better teaching and learning experience. Investing in educational technologies without appropriate and maximum use of it is waste of money of the exchequer. Educational administrators and policy makers need to come up with practical and effective plans to help teachers make the best use of the latest technologies by providing regular educational technology professional development for sustainable growth in achievements. Federal government, state government and school districts set apart substantial financial recourses for educational technologies with an intent that teachers with appropriate technology self-efficacy will make use of it the best way possible in the classroom teaching, ultimately resulting in better student outcome. Thus, the present study compels people with higher responsibility to subject the existing practices including technology professional development program for an auditing.

Educational technologies continue to emerge and evolve (Koehler, Mishra, & Cain, 2013) requiring professional development of teachers' practical knowledge to keep up. As it has already been stated, the main focus of the present study was revolving around teachers' technology professional development following the technology Pedagogical Content Knowledge theoretical framework (TPACK) because technology holds the capacity to support pedagogies to create learners as active participants. In the present study, the researcher analyzed those selected factors related to teachers' educational technology professional development and arrived at the conclusion that those teachers with higher TPACK self-efficacy gained through regular participation in the technology professional development program had their students achieve higher mathematics score in the assessments. This implies that educational leaders and policy makers need to envision a robust and regular professional development program for teachers with enhanced financial recourses. This helps to achieve better learning outcome in students. This study also helps all institutions and educational leaders to plan and prepare teachers technology professional development program to improve their TPACK self-efficacy ultimately resulting in better outcome in the use of the latest educational-technological theories. The importance of existing research on teachers' professional technology development is reiterated through this quantitative study. The researcher's findings highlight that teachers are motivated and prepared to engage in professional development that is relevant and valuable for their teaching practices in the classroom.

Recommendations for Practice

The present study has national implications for education, as it can help teachers improve their implementation and adherence to the Common Core State Standards (CCSS), which prioritize the use of technology in the curriculum. The CCSS emphasize the importance of teachers using technology to enhance their teaching-learning process, and being able to evaluate technological tools and address any problems that may arise. States and districts require to find affordable and teacher-friendly ways to incorporate technology into the CCSS and develop effective strategies to help teachers integrate technology into their instructional practices.

Technology today is an essential component of education. Policy makers and administrators must acknowledge its importance in the classroom. In order to remain competitive with other countries in a pan global context, the nation must continue to adapt to new technological professional development. In recognition of this, the US Department of Education published a National Education Technology Plan in 2010 with the aim of improving the nation's economic competitiveness. The present study focused on technology professional development for teachers using the Technological Pedagogical Content Knowledge framework (TPACK), which emphasizes integrating technology into teaching-learning process for better outcomes. The study found that teachers who received technology professional development had significantly higher scores on the eighth-grade mathematics achievements. Therefore, states and districts should invest in more advanced technology professional development to improve student achievement and prepare students for global competition. Allocating more funds for technology professional development can lead to improvements in students' achievement and help create a competitive society on a global scale.

Further, the information from the present study can be used by colleges nationwide to update their teacher preparation programs. Integrating TPACK skills into these programs will offer a more comprehensive approach to educating teachers and help them become more versatile educators. Professional development program designers should also take note of the present study outcome while creating workshops and training sessions for educators. The findings can help them integrate effective teacher professional development that can positively impact student learning, which should always be the ultimate goal of any educational technology professional development program.

Limitations

In the present study, there are numerous limitations. This study based itself on the 2013 eight grade NAEP mathematics students' and teachers' background variables reported based on questionnaires. They face all the limitations of self-reporting data. It is probable that non-sampling errors could have been made in the process of collecting data. The existing restrictions on consolidating dependent variables (all twenty plausible values) creates difficulty in having accuracy of overall hierarchical output matching to that of the dependent variable in AM Beta regression analysis. The theoretical framework was based on a larger body of research. However, the study was limited primarily to one variable in the data set. The statistical analysis is a correlational prediction and does not necessarily predict the causal implications. The limitations of the use of AM beta software restrict the combining of all the plausible values as one dependent variable for the purpose of hierarchal regression in SPSS. In addition, it is to be noted that NAEP uses plausible values to represent student answers to their own NAEP administered questions. Plausible values cannot be considered as an individual's test scores or an average score. The measurements are based on the answers given by representative group of students to each question. While the measurements are carefully constructed to reduce potential issues with validity, they are not flawless.

Future Research

For future studies, the latest NAEP data set could be used. According to Wenglinsky's (1998) argument, there is evidence that implementing educational technologies has a positive effect on student test scores, as demonstrated by a study. There are many advancements taking place both in technologies and NAEP questionnaire since 2013. And the 2014 NAEP recommends incorporating additional technology-related factors. To more precisely gauge the connection between educational technology professional development and mathematics achievement, future research could explore these new metrics. The present study was revolving around the TPACK framework. In future research, possibilities of looking at technologies through other theoretical lenses might results a different result. This study can also be replicated to see if the result would be same for reading as well. Future studies could use the latest NAEP restricted data set to see if the outcome is consistent with the present study. The discovery of the study is interesting. School districts may use the findings of the study to research which particular professional development technologies are most effective in the classroom and offer more professional development in those areas. Additionally, further investigation could be conducted into the various types of technology devices that could have a beneficial impact on student achievement in the classroom.

APPENDIX A IRB APPROVAL/EXEMPTION

ST. JOHN'S UNIVERSITY

Federal Wide Assurance: FWA00009066

Jan 23, 2023 8:53:43 AM EST

PI: Aneesh Mathew
CO-PI: James Campbell
Dept: The School of Education, Ed Admin & Instruc Leadership

Re: Initial - IRB-FY2023-145 *EXPLORING THE EFFECTS OF TECHNOLOGY PROFESSIONAL DEVELOPMENT ON THE 8TH GRADE NAEP MATHEMATICS ACHIEVEMENT*

Dear Aneesh Mathew:

The St John's University Institutional Review Board has rendered the decision below for *EXPLORING THE EFFECTS OF TECHNOLOGY PROFESSIONAL DEVELOPMENT ON THE 8TH GRADE NAEP MATHEMATICS ACHIEVEMENT*.

Decision: Exempt

PLEASE NOTE: If you have collected any data prior to this approval date, the data must be discarded.

Selected Category: Category 4. Secondary research for which consent is not required: Secondary research uses of identifiable private information or identifiable biospecimens, if at least one of the following criteria is met:

(i) The identifiable private information or identifiable biospecimens are publicly available;

(ii) Information, which may include information about biospecimens, is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained directly or through identifiers linked to the subjects, the investigator does not contact the subjects, and the investigator will not re-identify subjects;

(iii) The research involves only information collection and analysis involving the investigator's use of identifiable health information when that use is regulated under

45 CFR parts 160 and 164, subparts A and E, for the purposes of "health care operations" or "research" as those terms are defined at 45 CFR 164.501 or for "public health activities and purposes" as described under 45 CFR 164.512(b); or

(iv) The research is conducted by, or on behalf of, a Federal department or agency using government-generated or government-collected information obtained for nonresearch activities, if the research generates identifiable private information that is or will be maintained on information technology that is subject to and in compliance with section 208(b) of the E-Government Act of 2002, 44 U.S.C. 3501 note, if all of the identifiable private information collected, used, or generated as part of the activity will be maintained in systems of records subject to the Privacy Act of 1974, 5 U.S.C. 552a, and, if applicable, the information used in the research was collected subject to the Paperwork Reduction Act of 1995, 44 U.S.C. 3501 et seq.

Sincerely,

Raymond DiGiuseppe, PhD, ABPP
Chair, Institutional Review Board
Professor of Psychology

APPENDIX B IRB COURSE CERTIFICATE OF COMPLETION

Certificate of Completion

ST. JOHN'S UNIVERSITY

fhi360 THE SCIENCE OF IMPROVING LIVES

THIS ACKNOWLEDGES THAT

Aneesh Mathew

HAS SUCCESSFULLY COMPLETED
THE IRB COURSE IN THE PROTECTION OF HUMAN SUBJECTS

Raymond DiGiuseppe

11 October 2022

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